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Improved techniques for construction of snow roads and airstrips

Sung M. Lee, Wilbur M. Haas and Albert F. Wuori

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Rammsonde profile measurements and surface strength (Clegg impact) tests were conducted at selected sites in Antarctica on the snow roadways between McMurdo Station and Williams Field as well as on the aircraft skiway. Rammsonde measurements were also made at several points on the South Pole Station skiway, taxiway and construction sites. Snow pit data were collected at various locations at McMurdo and South Pole Stations. The purpose of the snow pit work was to investigate possible correlation between Rammsonde hardness data of the snowpack and the snow characterization data consisting of profiles of temperature, density, stratification, grain size, and metamorphic state. California Bearing Ratio (CBR) testing, to supplement previous work, was done in a laboratory coldroom at Michigan Technological University using snow that had been harvested near Houghton, Michigan, during the winter of 1985-86. A report on this will be published separately. The samples were prepared in a compaction machine and tested after sintering times of 7, 14 and 21 days at -10°C. A field test was conducted in Houghton with binder/additive-snow mixes in situ. ~~The results of this field test~~ are also ~~included~~ in this report.

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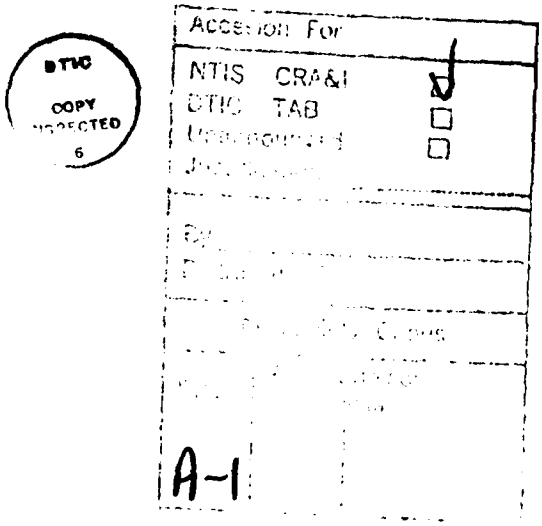
PREFACE

This report was prepared by Dr. Sung M. Lee, Dr. Wilbur M. Haas, and Albert F. Wuori, of the Institute of Snow Research, Keweenaw Research Center, Michigan Technological University, Houghton, Michigan. It describes the studies performed during FY 86 under NSF Project S-311 (contract DPP-8517148) for developing improved methods for constructing snow roads and runways in Antarctica. In order to observe, first hand, the type of problems encountered in the snow roadways during the austral summer season and to collect relevant data, two investigators (S. Lee and W. Haas) visited Antarctica for 11 days in January 1986.

Independently from the currently funded project, a study was conducted by Dr. Robert L. Brown of Montana State University that aimed at developing suitable binder-snow mixes and a method to process snow for higher compaction strength. Since that study had the objective of supporting the research conducted for the Project S-311, its results are included in this report.



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Improved Techniques for Construction of Snow Roads and Airstrips

SUNG M. LEE, WILBUR M. HAAS AND ALBERT F. WUORI

Snow compaction has been utilized to some degree for hundreds of years for trails and roads. Not until the middle of this century, however, was there any significant effort to understand snow behavior in its relation to construction. The two decades following World War II saw greatly increased activity in this area due to military deficiencies in the Arctic and scientific exploration in the Antarctic. The last two decades have seen increased resource development in the Arctic and Subarctic by the United States and Canada as well as the Soviet Union and others; this development has resulted in significant advances in snow compaction technology. However, these advances have not specifically addressed the problem of snow compaction technology for roads or runways for wheeled aircraft in extremely cold areas such as Antarctica.

Prior to the middle of this century, snow compaction for roads and trails was performed by field-expedient techniques such as drags and sometimes simply by sled traffic. When wheeled vehicles became common in the regions, these methods were not adequate, and so large rollers began to be used. During World War II, when heavy aircraft were introduced, it was apparent that new techniques had to be developed.

Since World War II, both the U.S. Army Cold Regions Research and Engineering Laboratory (CRREL), responding to military needs, and the U.S. Navy Civil Engineering Laboratory (NCEL), in support of antarctic geophysical explorations, began to develop snow processing and compaction techniques and equipment. These techniques were based on some understanding of the behavior and properties of snow such as its sintering (or age-hardening) process. When snow is disturbed by agitation or disaggregation, it begins to sinter and harden at a rate much more rapid than the metamorphosis of undisturbed snow. This phenomenon was exploited by developing disaggregation techniques utilizing soil mixers or rotary snow plows followed by compaction with rollers or vibratory devices as well as by the use of additives. At temperatures above approximately -18°C, these processes resulted in surfaces of sufficient thickness and strength to accommodate moderately heavy aircraft.

Methods of measuring snow strength have included testing with the Swiss-developed Rammsonde, an impact cone penetrometer; measurements of compressive strength, and determination of the California Bearing Ratio (CBR), which has been extensively used in pavement work so that the correlation between CBR results and pavement performance is well known. The limitation of the CBR is that it has only a modest theoretical basis, being mostly empirical. It is sufficiently promising, however, that more work is merited.

The problem of maintaining snow roads and airstrips at relatively high ambient temperatures (0°C ±5°C), when processed snow tends to become cohesionless due to destruction of intergranular bonds, combined with agitation by traffic, is a technical area requiring further study. Surface stabilization and covering or reinforcement with binder materials are potential solutions.

At very low temperatures, e.g. -20° to -40°C, laboratory work and field studies in the Antarctic have revealed that heat or free water must be added to the snow to promote the process of bonding of snow grains and to achieve the increase in strength necessary for supporting heavy wheeled aircraft. Other possible methods of increasing the strength of the snow, based on past experience, are use of binder materials and landing mats or other suitable surface strengtheners. Aside from logistical considerations, study is still needed to demonstrate feasibility of these approaches.

An excellent literature resource for the state of the art in compacted snow runways is a comprehensive monograph on this subject being prepared and published by CRREL (Abele, in prep.). This will have over 300 literature references on the subject.

RAMMSONDE HARDNESS AND CLEGG IMPACT VALUE DATA

The purpose of the Rammsonde studies was to obtain baseline or background data on snow conditions, especially on the Shuttle Road from McMurdo to Williams Field, the parallel "Delta Road," and the skiway at Williams Field, and the aircraft skiway at South Pole Station. These data would permit some evaluation of the feasibility of increasing the strength of the snow for carrying wheeled shuttle vehicles and, ultimately, providing for landing wheeled aircraft.

The Rammsonde data have the advantage of previous correlations established between the wheel loadings for certain aircraft and the required Ramm value (Abele et al. 1968). In addition, a tentative relationship has been developed between the Rammsonde hardness value (R) and the CBR (CBR = $1.25\sqrt{R}$; from data by Wuori [1960] and Russell-Head et al. [1984b]). The Rammsonde studies typically evaluated snow conditions to a depth of 50 cm or more, which is approximately the depth to which the snow would be significantly stressed by aircraft wheel loads.

The Clegg impact device has been developed to complement the CBR test in soils work. It is a surface impact test in which the Clegg impact values (CIV) increase as the road surface strength increases. The CIV has been correlated with the CBR for soils (Alkire 1987). The commonly used expression is CBR = 0.07 $(CIV)^2$. The CIV is a complementary value to the Rammsonde reading, which is unreliable for approximately the top 10 cm.

McMurdo Rammsonde observations

Rammsonde hardness profile data were taken at selected locations on the snow road and skiway. Five stations were selected on the Shuttle Road, and five Rammsonde profiles were taken at each of these stations. As the Shuttle Road is nominally 60 ft wide, the Ramm profiles were taken at approximately 10-ft intervals across each section. Distances were measured from the line of orange flags marking the division between the Shuttle

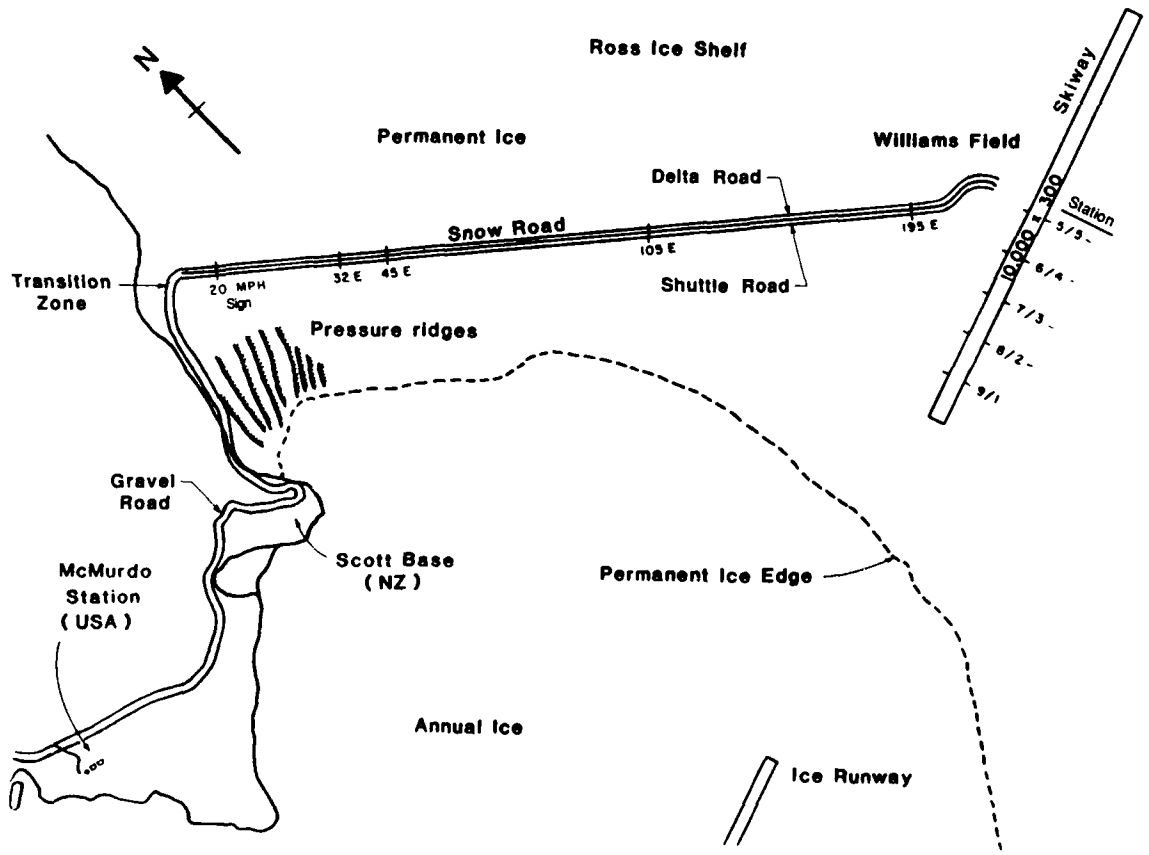


Figure 1. McMurdo Station, locations of measurements on Williams Field skiway and on the snow road.

Road and the Delta Road, and are indicated in the field notes and figures as "10 feet right, 20 feet right," etc.

As there was no readily available conventional stationing of the roadway, the locations were identified by available visible markers, such as the "20 MPH" sign at the western (McMurdo) end of the straightaway road section. Other stations were located by counting flags from this marker as the point of beginning; thus, succeeding locations are designated "32 east, 45 east," etc. Figure 1 shows the location of these stations relative to McMurdo Station and Williams Field. It also shows the locations of the Rammsonde profiles on the Williams Field aircraft skiway.

The typical positions of the five Rammsonde profiles at a given station are shown in more detail in Figure 2, which also shows the position of the "centerline" Ramm test on the Delta Road. The positions were established by sighting from the orange flag to its corresponding green flag and measuring the distance with a surveyor's tape to the nearest 0.1 ft. Although it was intended that the regular 10.0, 20.0, 30.0 ft (etc.) positions be maintained, these distances were modified to avoid what appeared to be a nonrepresentative snow condition. Thus the locations are not always on an exact multiple of 10 ft.

Rammsonde profiles were also taken in the presumed undisturbed snow to the south of the Shuttle Road (toward McMurdo Sound), at distances of approximately 25 ft and 200 ft from the edge of the road. While some of these profiles indicated very low strengths, in some instances it was clear that previous traffic by sled train or other vehicles had indeed modified the snow. Rammsonde profiles were also taken on the centerline of the Delta Road at the same stations as indicated above. In general, the Delta Road Ramm values showed somewhat higher strengths than those from the Shuttle Road.

Rammsonde profiles were also taken on the centerline of the Williams Field skiway at five "stations" spaced at 1000-ft intervals, as indicated by the distance markers along the edges of the runway. In addition, profiles were also taken at about 20 or 25 ft on either side of centerline for most of these five stations. The Ramm values on the skiway were generally considerably lower than those on the Shuttle or the Delta Road. Figures 3, 4 and 5 present examples of the Ramm data.

Figure 6 shows two typical (high & low) Ramm profiles of the Delta Road. Also shown is a required profile for the large, wheeled Delta 2 vehicle, which was derived on the basis of its GVW of 43,500 lb, two axles, four wheels, with an assumed

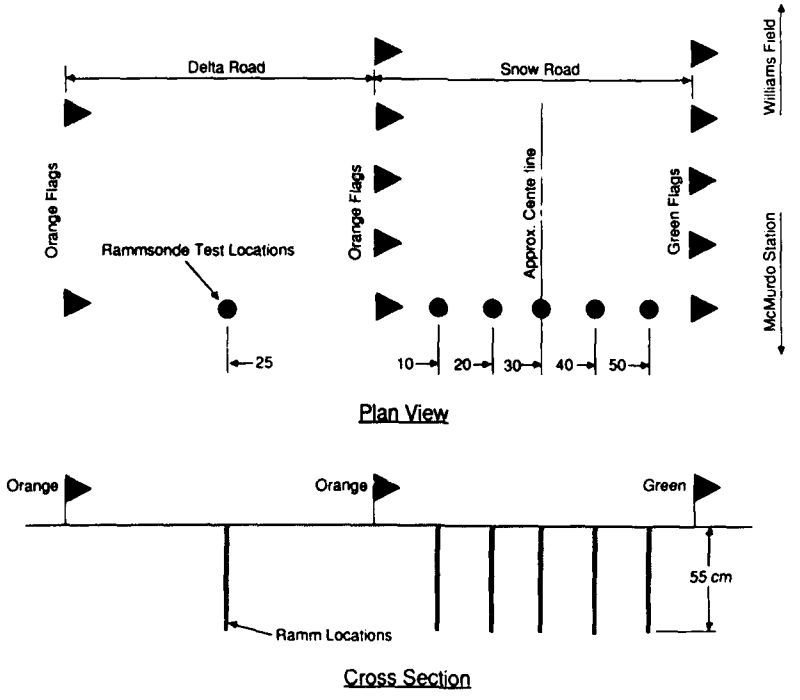


Figure 2. Detailed location of Rammsonde tests, Snow Road, McMurdo Station to Williams Field. All dimensions in feet unless noted.

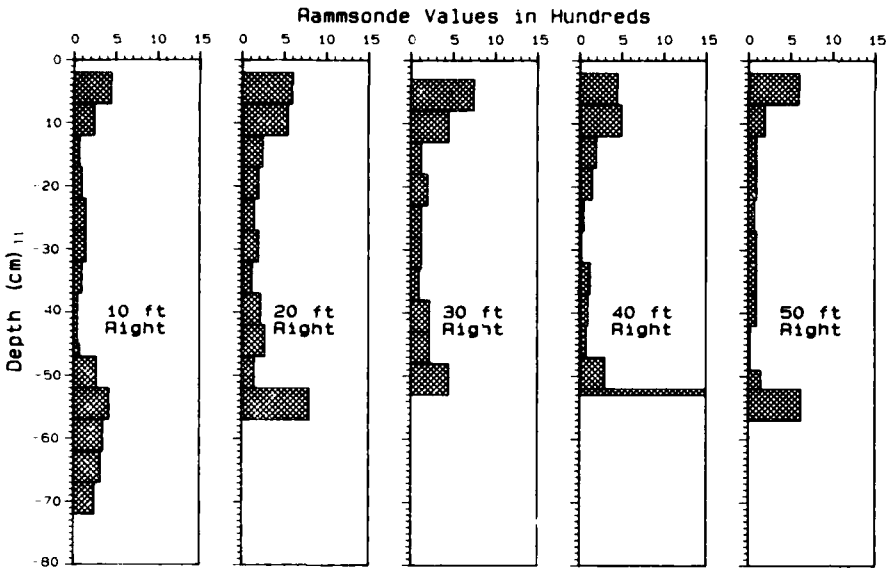


Figure 3. Shuttle Road Station 32 east, 8 January 1986.

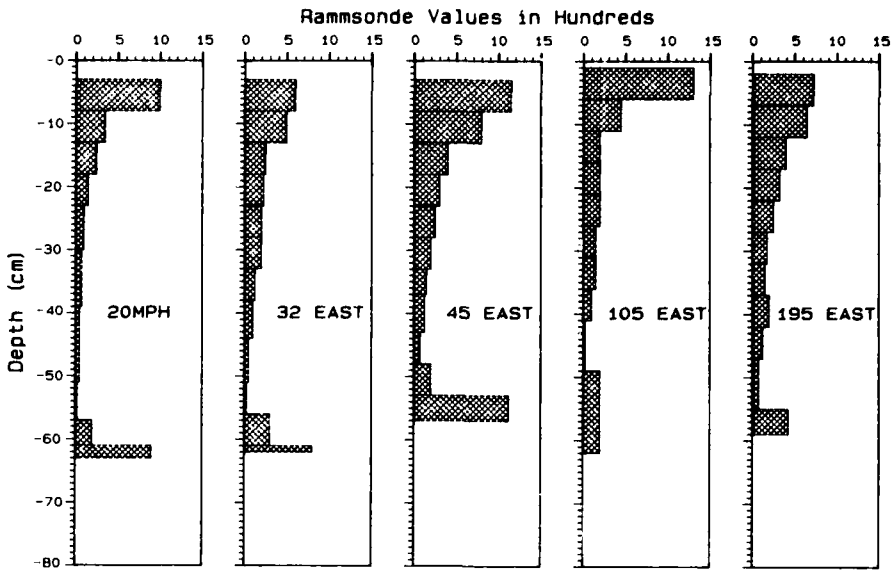


Figure 4. Delta Road centerline, 13 January 1986.

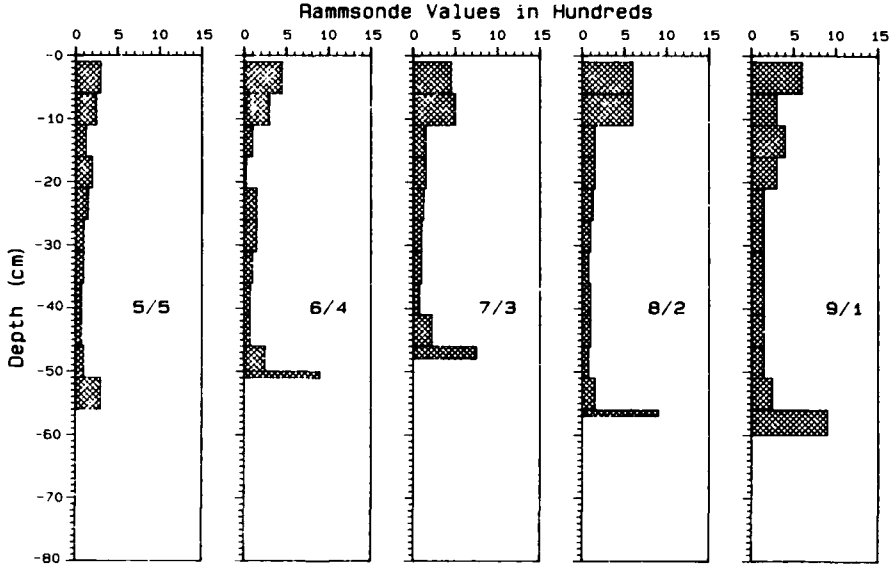


Figure 5. Williams Field skiway centerline, 10 January 1986.

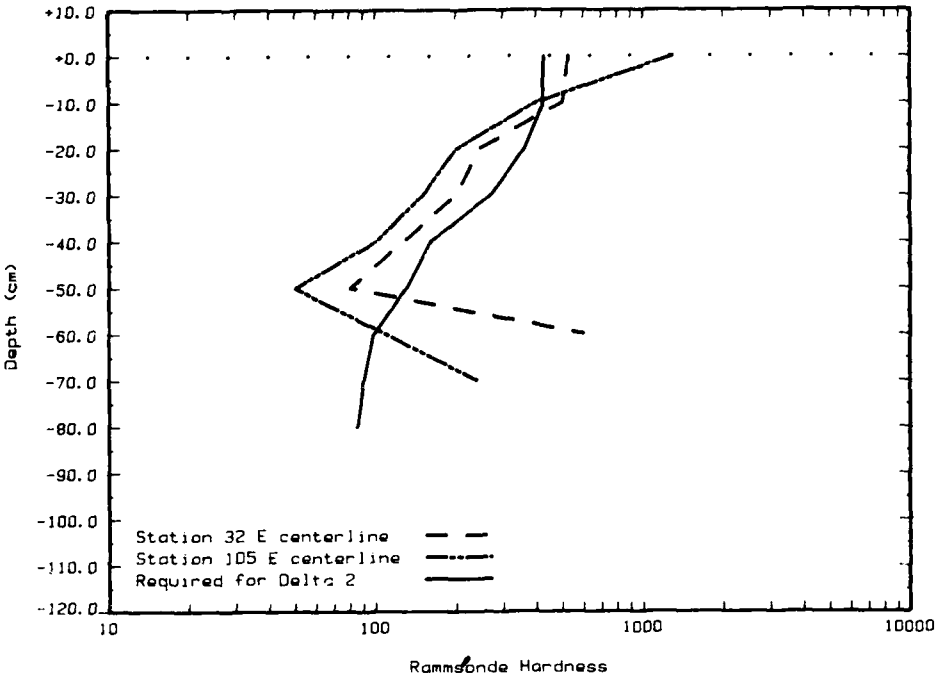


Figure 6. Rammsonde profile of the Delta Road.

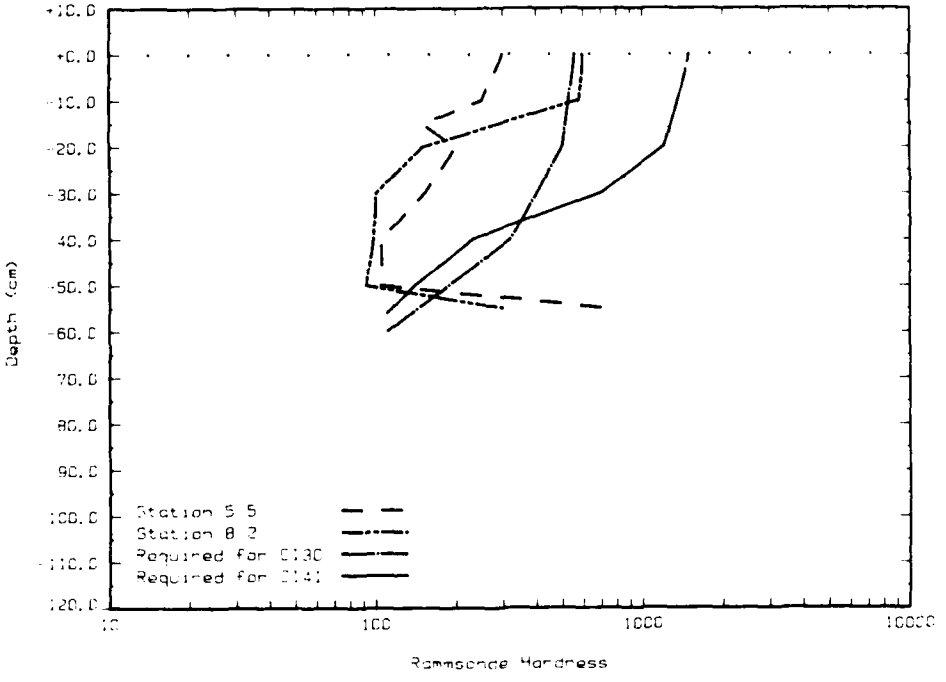


Figure 7. Rammsonde profiles of Williams Field skiway at the centerline.

load of 11,000 lb per wheel and 18-psi tire pressure. It can be seen that while the surface layer of 20 cm or so is adequate in strength, the strength at depths of 20 to 50 cm is quite marginal. The strength beneath 55 cm is more than adequate because of a hard icy layer, which will be discussed later in the snow pit data section for McMurdo. The marginal strength at 20 to 50 cm may account for the occasional failures on the Delta Road, especially during the warm season.

Figure 7 shows two typical (high & low) Ramm profiles of the skiway at the centerline. Also

shown are required hardness profiles for the C-130 and C-141 aircraft (wheels). It can be noted that the hardness of the top 55 cm is inadequate for both aircraft. Because of the ice layer mentioned above, the strength below 55 cm is more than adequate. The top 55 cm would require a moderate degree of processing, compaction and/or additives in order to support a wheeled C-130, an increase in the Ramm hardness ranging from 200 to 300. For support of a wheeled C-141, considerable processing and/or additives would be required to increase Ramm hardness to 800 to 1200.

Rammsonde profiles were also taken along the edge of the skiway in close proximity to the snow pits which were dug there. In addition, Ramm profiles were taken in the vicinity of the buildings at Williams Field, where a snow fill had recently been constructed. This showed relatively high Ramm values, typically about 500 or more.

Clegg impact values (CIV)

In recent years, the Clegg impact device has been developed as a supplemental tool to the California Bearing Ratio (CBR). It measures the deceleration of a standardized drop hammer upon impact with the soil, or for the purposes of this study, the snow. This impact value, CIV, has been correlated with the CBR for soils. It is believed that the CIV will also prove useful for evaluating initial snow conditions as well as the increase in

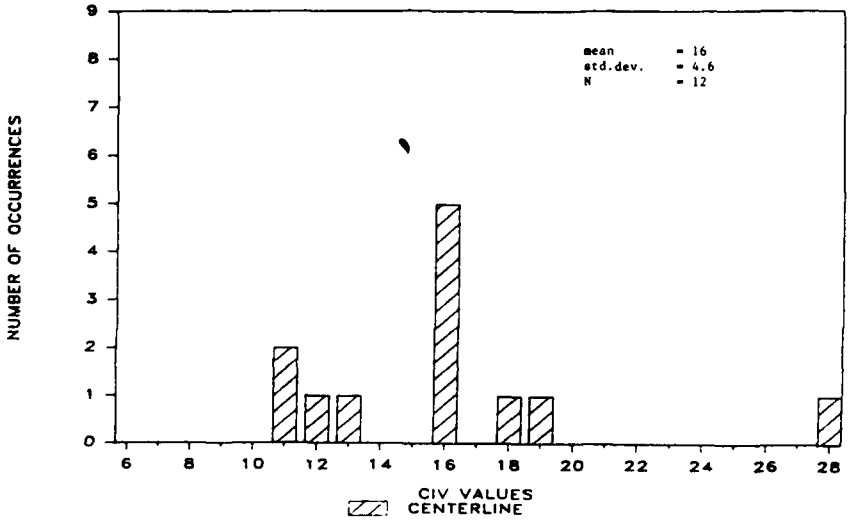


Figure 8. Clegg impact values, Shuttle Road centerline.

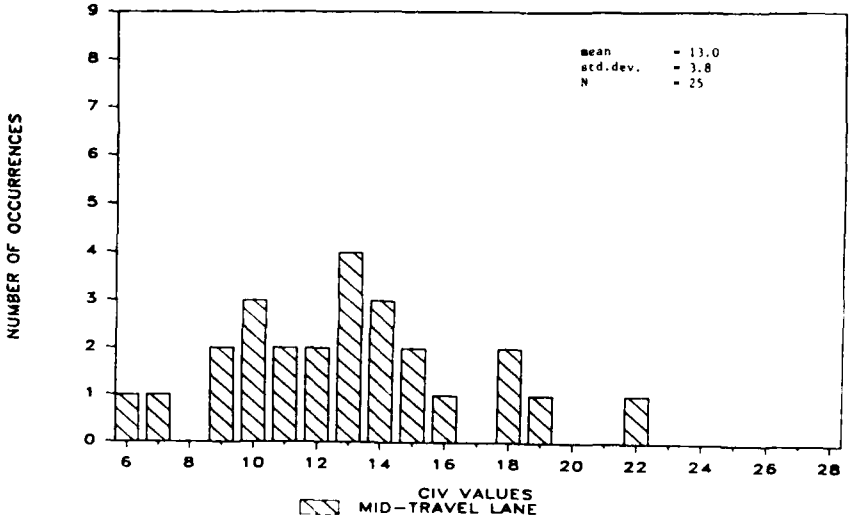


Figure 9. Clegg impact values, Shuttle Road, 10 ft on either side of the centerline.

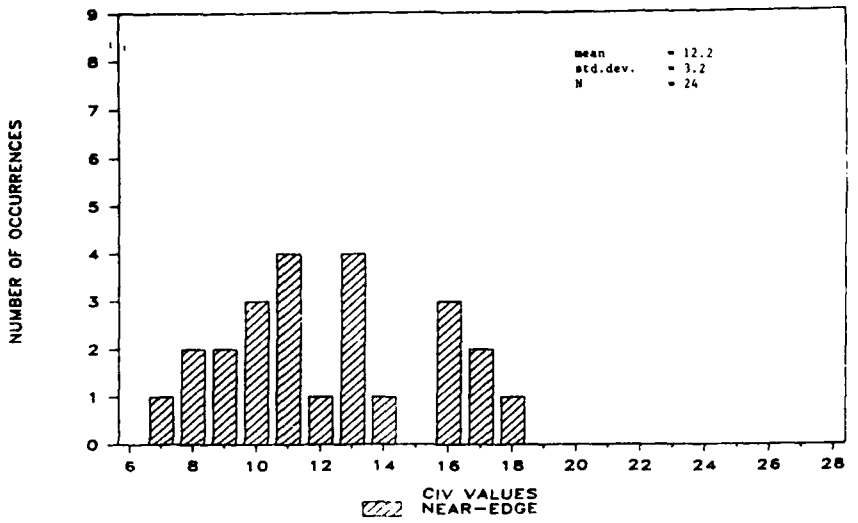


Figure 10. Clegg impact values, Shuttle Road, 20 ft on either side of the centerline.

strength caused by various snow processing procedures, including the use of admixtures. Since the CIV is specifically a surface test, it also complements the Ramm hardness values, which are unreliable at the surface.

CIVs were taken at essentially the same locations as the Ramm profiles. However, the CIVs were not taken at off-road or off-skiway locations where the snow surface strength was obviously so low that the impact value would not apply. The results are quite consistent with what might be expected, in that the average of the centerline values on the shuttle road was higher than the values approximately 10 ft on either side of centerline (midlane values), and the lowest values are 20 ft from the centerline (near-edge values). Specifically, the mean CIV of 12 measurements on centerline was 16.0, the mean of 25 CIV measurements at 10 ft either side of centerline ("mid-travel lane") was 13.0, and the mean of 24 CIV tests at 20 ft either side of centerline ("near-edge") was 12.2. These results are shown in histogram form in Figures 8, 9 and 10.

South Pole Rammsonde observations

Rammsonde hardness profile data were taken at selected locations at the South Pole Stations. The locations are indicated in Figure 11 and they include 50-ft intervals across the skiway at the 3000-ft and 6000-ft markers, as well as locations on the taxiway, and at several construction sites.

Figure 12 shows a typical Rammsonde profile of the South Pole skiway, which was taken along the centerline at the 3000-ft marker. The figure also illustrates the required Rammsonde profiles to support the C-130 Hercules aircraft and the C-141 Starlifter aircraft on wheels. These profiles were derived from previous testing by CRREL (Wuori 1962, Abele 1968). It can readily be seen that the

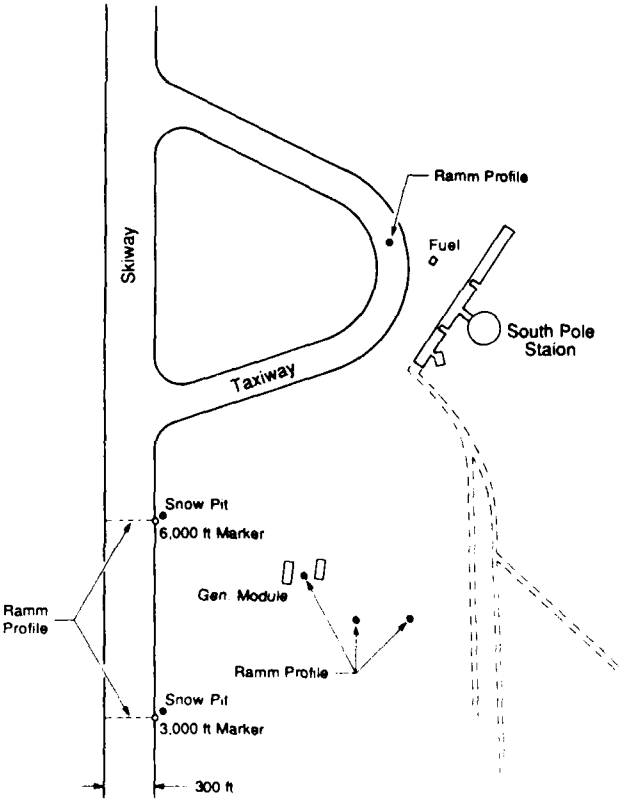


Figure 11. Locations of measurements at South Pole Station.

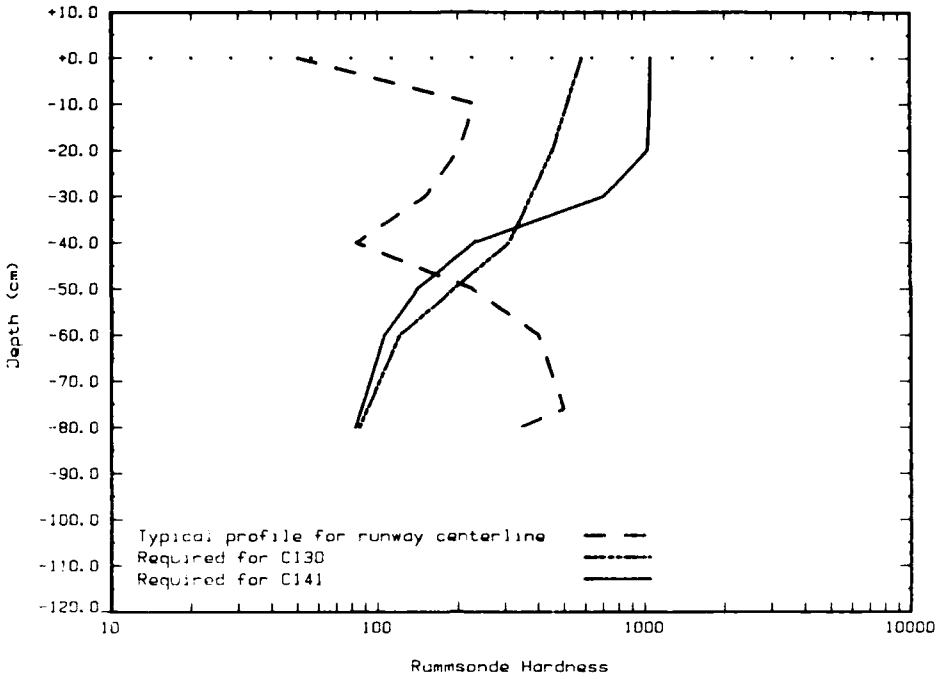


Figure 12. Typical Rammsonde profile of the South Pole skiway.

hardness (strength) at 50-cm depth and below is quite adequate to support the two types of aircraft because the wheel stresses diminish rapidly with depth. It may be noted that the C-130 requires a higher strength (or imposes a greater stress) at a depth of 37 cm and below than the C-141, even though a much lower strength is required for the C-130 at depths of zero to 37 cm because of its larger tire imprint area. For both aircraft the strength or hardness of the top 50 cm is inadequate. For the C-130, an increase in Ramm hardness number of approximately 300 is required; for the C-141, increases on the order of 100 to 1300 (at the surface) are required.

SNOW PIT DATA

A typical snow pit had dimensions of 1.5 m long, 1 m wide, and 0.8 m deep. Snow pit data are presented in Appendix A. Locations of the snow pits were chosen to be close to either the roadway or the skiway where the Rammsonde data were taken, with the view that the two sets of the data may have some correlation. As it turned out, the erratic nature of the Rammsonde data makes any quantitative correlation unlikely.

The snow pit data show density profiles, temperature profiles, grain size, stratification and metamorphic state. Photographs of snow crystals at different layers were taken but are not shown in this report.

Many of the snow conditions at McMurdo and South Pole differ, as one would expect from the different climates at these locations. But there are some similarities at the stations:

1. The snow is extremely dry.
2. The snow has little cohesion.
3. Density values range from 0.30 to 0.45 g/cm^3 or higher

McMurdo

The top surface of the snow pack has a thin (~ 1 cm) brittle melt-freeze layer. Below the surface, the snow is in various stages of temperature gradient metamorphism. Stratification is not very perceptible. However, very noteworthy structure exists in that there is a layer of hard ice, several centimeters to 30 cm thick, typically 40 cm below the surface. Below this ice layer, dry snow of more advanced metamorphic state is found. It may be speculated that this ice layer was formed by the combination of the freeze-thaw process during the preceding season and compaction by traffic on the road.

The existence of the ice layer is significant since it can be used as a base on which processed snow can be compacted.

South Pole

The metamorphic state of snow at the South Pole Station approaches that of constant temperature condition. There is no ice layer like the one in the McMurdo snow road.

The Rammsonde readings at a construction site of the South Pole station show, however, that when snow compaction and subsequent hardening are accomplished, the snow is likely to retain its strength. This is not to be expected at McMurdo where the summer season thawing will deteriorate the condition unless a better method is utilized to extend the useful life of the compacted roadway.

These observations suggest that the problems at the two locations must be treated by two different approaches.

SNOW-BINDER COMPOSITE DEVELOPMENT

In order to find a suitable strengthening material for snow and a processing method to enhance compaction, a separate laboratory study was conducted by Dr. R.L. Brown of Montana State University. Although this effort was not part of the currently funded NSF project, its results are included here because of its relevance to the project. Previous work on binder materials such as sawdust was performed by NCEL in the 1950s in Squaw Valley, California, at the Winter Olympics parking lots. Also, CRREL tests conducted in the 60s (Abele et al. 1968) showed promising results.

Test program

With an initially wet snow, it was necessary to reduce the size of particles. To separate the bulk material from the testing material, it was sifted through a $^{3}/_{8}$-in. sieve.

The mixtures were formed on a volume basis. One Proctor mold of wood sawdust mixed with four Proctor molds of snow (loose measure) is an example of how the items were mixed. The six mixtures used were: 1 part wood to 4 parts snow, 3 parts wood to 4 parts snow, 5 parts wood to 2 parts snow, 1 part polystyrene to 4 parts snow, and 5 parts polystyrene to 2 parts snow. For each test there were pure snow samples to be used as controls.

Compaction was achieved by using a 5.5-lb hammer falling through a 12-in. drop. Each mold was compacted using three layers with 25 blows per layer for a total compactive effort of 12,375 ft-lb/ft^3. The temperature was -14°C during mixing and compaction.

After compaction, each cylinder was allowed to cure at -14°C temperature for 24 hours. It was then taken to the press and immediately compressed by a load of 2000 lb or to a total displacement of 1.2 in., whichever occurred first. All samples but one achieved the 1.2-in. displacement. The strain rate used with all samples was 2 in./min.

Only 14 cylinders were available for use, which made it necessary to make three test runs. Three cylinders of each mixture and the control were used for the dry test runs while two cylinders of each mixture were used in the wet test run for a total of 52 specimens.

The sample preparation for the wet test was the same as that for the dry test. The sample was taken from the freezer and set in the room at a temperature of 25°C. A thermocouple was placed at the center of the sample (2 in. from the nearest boundary), and the specimens were allowed to warm until the reading was 0.0°C. Informal checks were made on the material in the boundaries, and these temperatures were found to be approximately 5°C higher than those at the core.

It should be noted that the samples shrank in an inverse ratio to their additive concentration during the wet test. During the compaction of the polystyrene, there was a stratification buildup due to the vibration. The worst case was in the highest concentration of polystyrene.

Results

1. The polystyrene beads were largely ineffective in increasing the load carrying capacity of the snow. In fact, the beads had an overall negative effect on material stiffness and strength.

2. The results for the wood were mixed. At low volume fractions of wood, the strength was increased, while at higher concentrations of sawdust, the strength was actually decreased (see Fig. 13).

3. In general, there was a very strong dependence on the volume fraction of the binder material in the mixture. This was seen in the strength, stress-strain properties and density.

4. The performance of the mixture was adversely affected when the material was wet, as should have been anticipated, since wet snow is normally weaker than dry snow when other factors are equal (see Fig. 14 and 15).

5. Some important factors were not investigated in this preliminary study because of time restraints. For instance, the mechanical properties of the mixture can be substantially affected by changing the relative size of the snow grains and the binder particles, as predicted by mixture

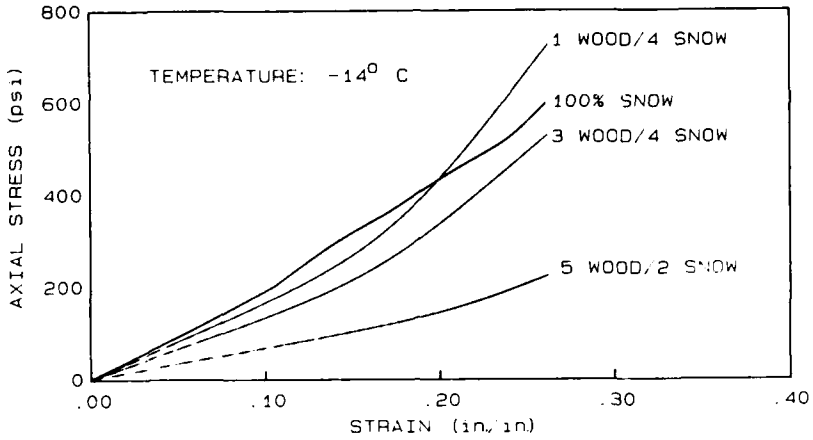


Figure 13. Sawdust/snow mixture, dry snow.

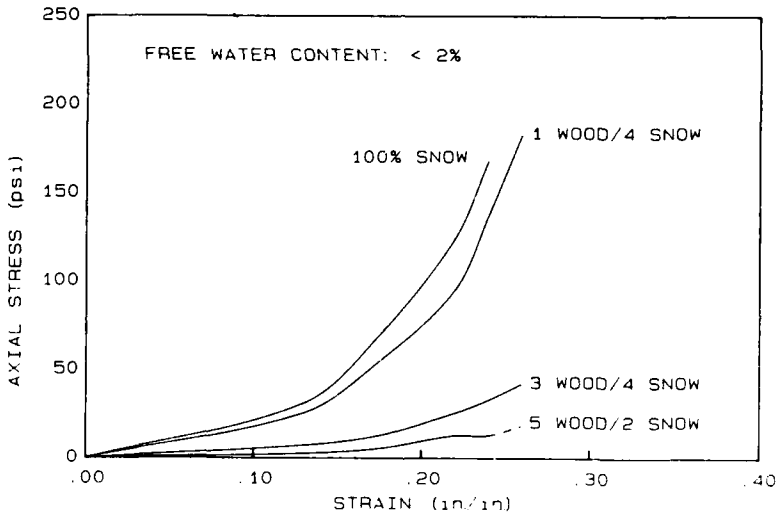


Figure 14. Sawdust/snow mixture, wet snow.

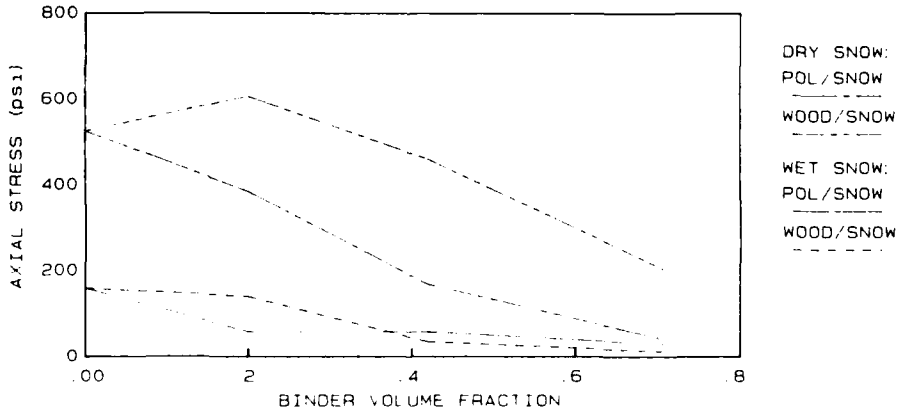


Figure 15. Axial stress vs binder volume.

theory. Also different mixture preparation procedures could result in improved material properties.

6. It was shown that performance enhancement of the mixture is possible if the correct binder material and mixture preparation procedures are used. More investigation is needed to answer some of these questions.

FIELD TEST OF SNOW-BINDER COMPOSITE MATERIALS

In an attempt to construct and monitor several different combinations of binder/insulator to improve the strength properties of antarctic roads and runways, a pad system was built near the Keweenaw Research Center. A site was selected to simulate the conditions in Antarctica as closely as possible. The area used has no large trees to block sunlight. The pad system was oriented to maximize the removal of freshly fallen snow by wind. Construction of the pads was started late in the winter season in an attempt to simulate the equi-temperature metamorphic snow type found in the polar regions. The pads were built large enough (6×6 ft) to ensure that melting from the edges would not severely affect the results.

The pads are being visually monitored, and measurements were made of degradation of strength and thickness. Large snowfalls were carefully removed to eliminate any insulating effect from an overlying snow blanket.

Pad construction

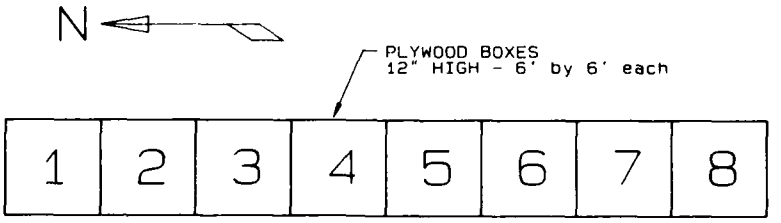
The construction of pads composed of snow, binder and/or insulator was performed by using various combinations of the above materials in an attempt to achieve the required strength as well as to insulate the pads and minimize the weakening due to thawing temperatures.

Eight plywood boxes, 6×6 by 1 ft high, were built. The area under the boxes was heavily iced and kept clear of snow throughout two weeks of cold weather to freeze the ground as deeply as possible to simulate antarctic conditions before the pads were built (Fig. 16).

At the time the snow was transferred into the boxes, it had metamorphosed to a combination of equi-temperature and temperature-gradient crystals. These large, loose crystals should closely compare to the equi-temperature composition of the antarctic pack. A snow blower was used to transfer the snow into the boxes to simulate the envisioned construction process on a large scale.

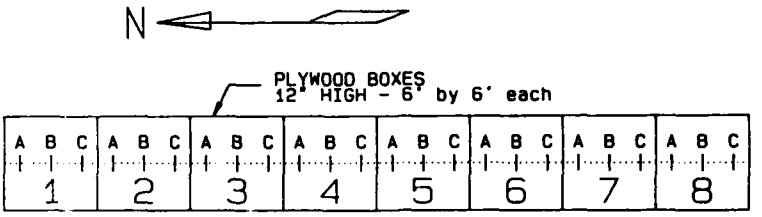
The snow was put in the boxes in varied layer thicknesses, as shown on the accompanying pad layout drawing (Fig. 16). Each lift was sprinkled with water to bond the crystals and to compact the system. The binder/insulator layers varied in thickness as shown in the figure. Each lift of binder was also wetted to compact and freeze it into the system.

Pads 2 and 8 used beadboard as an insulator. The beadboard consisted of Styrofoam beads about $^1/_8$ in. in diameter. Pads 3, 4, 5 and 6 were composed of hardwood chips ranging from $^1/_{16}$ in.



1. ALL SNOW
2. SNOW IN 2 6" LIFTS with 1" BEADBOARD on TOP of EACH LIFT
3. SNOW in 2 6" LIFTS with 1/2" SAWDUST on TOP of EACH LIFT
4. SNOW in 2 6" LIFTS with 1/2" WHITE SAWDUST on TOP of EACH LIFT
5. SNOW in 1 12" LIFT with 1" SAWDUST on TOP
6. SNOW in 1 12" LIFT with 1" WHITE SAWDUST on TOP
7. SNOW in 1 12" LIFT with 1 LAYER of FIBERGLAS on TOP
8. SNOW in 8" LIFT with 1" BEADBOARD on TOP and 3" SNOW OVER THAT

Figure 16. Snow pad layout.



OBSERVATION MEASUREMENTS ON THE TEST PADS ARE TAKEN AT THE ABOVE LOCATIONS. MEASUREMENTS OF CHANGE IN PAD THICKNESS ARE MADE FROM THE TOP OF THE PLYWOOD BOXES TO THE TOP OF THE PAD AT EACH LOCATION ON THE 8 PADS. RAMMSONDE HARDNESSES ARE OBTAINED FOR EACH PAD AT LOCATION B.

THE POINTS A, B AND C ARE LOCATED ALONG THE TRANSVERSE CENTER LINE OF THE LAYOUT STARTING ONE FOOT IN FROM ONE EDGE, THE CENTER AND ONE FOOT IN FROM THE OPPOSITE END.

Figure 17. Pad observation measurement locations.

square to ⅜ in. square with essentially no thickness. The white sawdust was obtained by soaking approximately 4 ft³ of dry sawdust with 3 gal. of paint and 30 gal. of water. The mixture was spread onto the snow as a slurry. The binder on pad 7 was a layer of white fiberglass cloth consisting of three ¼-in.-thick pieces of the cloth placed on top of each other. Pad 1 was an all-snow pad used as a control (Fig. 17).

Once all of the pads were built, they were sprinkled at the same time to make sure they all began to change at the same time.

Results

After the pads were completed, they were observed for a period of several weeks.

It was determined that the pads using sawdust had a considerably higher strength than the ones with beadboard and fiberglass. The pads with white sawdust did not melt down as rapidly as those with the natural sawdust, but no observed strength difference was apparent early after construction. By the morning of 4 April, pads 1, 2 and 8 were melted to the ground. Pads 3 and 5 had the lowest rates of melting at this time and their strength also held up well. On 16 April, pads 4 and 7 had essentially melted to the ground and pad 6 was 75% gone. Pads 3 and 5 had only melted down 25%, with pad 3 showing the least degradation. Both of the pads were still strong enough to support a man. On 22 April, all the pads were gone. After the thawing period in early April, Clegg tests revealed that the white sawdust preserved the strength longer than the natural sawdust. On the basis of limited observations, the mixes in plots 4, 6 and 7 seemed to give the best results. This is based on relatively high Clegg impact values combined with relatively low penetrations of the Clegg drop hammer. High CIVs are interpreted to mean relatively high strength and stiffness.

The penetration mentioned above is measured as the depth of the impact cavity formed by the falling hammer. This measurement is not a part of the conventional Clegg test procedure, but was initiated in the Clegg procedure as performed in Antarctica in January 1986. The significance of this penetration is not yet firmly established, but it

Table 1. Clegg impact values measured on snow pads at Keweenaw Research Center.

Pad	*CIV(4)**	*Penetration (ft)*	*CIV(8)*	*Penetration (ft)*
3	10	0.10	†	—
	8	0.20	†	—
4	76	0.10	†	—
	36	—	56	0.04
	46	—	67	0.03
5	12	—	64	0.17
	19	—	58	0.15
	13	0.09	†	—
6	46	—	64	0.08
	46	—	58	0.04
	39	0.13	†	—
7	51	—	53	0.05
	53	—	57	0.05
	41	0.02	†	—

* CIV(4)—CIV recorded after four drops of the hammer, CIV(8)—CIV recorded after eight drops of the hammer. The penetration was measured only at the end of the test, after either four drops or eight drops.

† Not done.

seems reasonable that small penetration depths would indicate a stronger material, while large penetrations would suggest a relatively weak or yielding material. Furthermore, high CIVs are usually (but not always) associated with low penetrations.

The CIVs and corresponding penetration values are shown in Table 1. The snow in pads 1, 2 and 8 had deteriorated to the extent that CIV tests would not be meaningful.

CONCLUSIONS

The snow pit and Rammsonde data lead to a conclusion that the snow road and skiway improvements at McMurdo and South Pole Stations require two different procedures.

At McMurdo, the hard ice-layer found approximately 40 cm below the surface can be used as a base on which compaction of snow can be accomplished. Relative high temperatures at McMurdo will also promote sintering or age hardening of processed snow or snow/binder mixtures, although thawing temperatures are detrimental. At South Pole Station, the extremely low snow temperatures require some form of heat treatment at some depth in the top 40–50 cm in order to form a base on which processed snow can be compacted.

The snow-binder mixture study shows promising results. Sawdust mixed in small volumetric proportion to snow increases the compaction strength. Field tests also show that such a mixture withstands warm weather and retains its strength for a longer period than pure snow.

Based on these observations, a snow-binder (such as sawdust) mixing technique and snow processing methods are being proposed to be implemented on test sections on the snow road at McMurdo and on or near the taxiway at the South Pole Station. Several layers of snow-binder mixture, compacted one layer at a time, will likely accommodate safe traffic with low maintenance on the snow road to Williams Field. This type of surface should be particularly effective in the transition zone where thawing and rutting is made worse by soil on the snow road. Also, it is quite possible that the snow-binder technique will be effective in upgrading the Williams Field skiway to safely accommodate wheeled aircraft such as the C-130 throughout the thawing season. To accommodate C-141 aircraft, it will likely be necessary to heat-process the snow to 40-cm depth.

The South Pole Station skiway will require heat processing to upgrade it to accommodate wheeled aircraft. At this time, it is not known whether binder materials will be effective in that low temperature regime with or without heat processing. It is important to field validate first the snow/binder materials concept at both McMurdo and South Pole and then later the heat processing techniques.

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APPENDIX A: SNOW PIT DATA, MCMURDO AND SOUTH POLE STATIONS

CLASSIFICATION SCHEME FOR SNOW
(By R. A. Sommerfeld)

I. Unmetamorphased

- I.A No wind action
- I.B Wind blown
- I.C Surface hoar

II. Equitemperature metamorphism

Decreasing grain size
- II.A.1 Beginning
- II.A.2 Advanced

Increasing grain size
- II.B.1 Beginning
- II.B.2 Advanced

III. Temperature gradient metamorphism

Early
- III.A.1 Beginning
- III.A.2 Partial
- III.A.3 Advanced

Late
- III.B.1 Beginning
- III.B.2 Advanced

IV. Firnification

Melt-freeze metamorphism
- IV.A.1 Limited
- IV.A.2 Advanced

Pressure metamorphism
- IV.B.1 Beginning
- IV.B.2 Advanced

Snow Pit Data from McMurdo Station

Date: 11 January 1986

Time: 11:00

Location: Williams Field Skiway, 5000 ft. marker, 25 ft. from the edge outwards.

Observer: S. M. Lee Recorder: S. M. Lee

Surface Crystal Size (mm): 1

Surface Density (g/cm^3): 0.39

Depth (cm)	0	10	20	30	40	50	60	70
Density (g/cm^3):	0.39	0.42	0.48	0.45	0.44	0.34	0.39	
Grain Size (mm):								
Metamorphic Classification:	IC	III.A.1	---------->				IV.A.2	IV.A.2
Temperature (°C):	-7	-5	-7.5	-8	-10	-12	-13	

Stratification: 1.5 cm surface crust 50-60 cm (hard ice)

Notes: Partly cloudy

Snow Pit Data from McMurdo Station

Date: 11 January 1986

Time: 13:25

Location: Williams Field Skiway, 7000 ft. marker, off the edge of skiway.

Observer: S. M. Lee Recorder: S. M. Lee

Surface Crystal Size (mm): 2

Surface Density (g/cm^3): 0.37

Depth (cm)	0	10	20	30	40	50	60	70
Density (g/cm^3):	0.37	0.48	0.47	0.44	0.35	0.43	0.42	
Grain Size (mm):	2	1	1	1	1	1	1	
Metamorphic Classification:	IC	III.A.1 ---------->			IV.A.2 ------->			
Temperature (°C):	-2.5	-6	-7	-9	-11	-12.5	-11	
Stratification:	Surface crust (soft)					42-50 (hard ice)		

Notes: Partly cloudy, moderate wind.
Snow tends to adhere more easily to equipment.

Snow Pit Data from McMurdo Station

Date: 13 January 1986

Time: 09:50

Location: McMurdo Roadway, 3.7 miles from transition area, median between path and Delta road.

Observer: S. M. Lee Recorder: S. M. Lee

Surface Crystal Size (mm): 1.5 ~ 2.0

Surface Density (g/cm^3): 0.41

Depth (cm)	0	10	20	30	40	50	60	70
Density (g/cm^3):	0.41	0.37	0.36	0.36	0.37	Hard ice -->		
Grain Size (mm):	1.5~2.0	1.0	>1.0	----->	1.0			
Metamorphic Classification:	IV.A.2	IV.B.1 ---------->						
Temperature (°C):	-6	-7	-8.5	-11.5	-10.5	-13.0	-12.0	
Stratification:						49-68 (hard ice)		

Notes: Sunny, no wind.
Excellent road condition, no problem for wheeled vehicles.

Snow Pit Data from McMurdo Station

Date: 13 January 1986

Time: 10:45

Location: McMurdo Roadway, 3.7 miles from transition area, off the edge.

Observer: S. M. Lee **Recorder:** S. M. Lee

Surface Crystal Size (mm): 1.5 ~ 2.0

Surface Density (g/cm^3): 0.32

Depth (cm)	0	10	20	30	40	50	60	70
Density (g/cm^3):	0.32	0.33	0.32	0.30	0.41	0.43	0.42	
Grain Size (mm):	1.5~2.0	1.0 ----->		<1.0	1.0	------->		
Metamorphic Classification:	I.C	IV.A.2 ---->		IV.A.1	IV.A.2 ---------->			
Temperature (°C):	-7.0	-7.0	-9.5	-10.0	-12.0	-13.0	-13.0	
Stratification:				30~34 (hard ice)				

Notes: Sunny, no wind.
Undisturbed area, wheeled vehicle not possible.

Snow Pit Data from McMurdo Station

Date: 13 January 1986

Time: 14:20

Location: McMurdo Roadway, 1.45 miles from transition area, off the edge.

Observer: S. M. Lee **Recorder:** S. M. Lee

Surface Crystal Size (mm): 1.5

Surface Density (g/cm^3): 0.42

Depth (cm)	0	10	20	30	40	50	60	70
Density (g/cm^3):	0.42	0.39	0.44	0.43	Hard ice ---->			
Grain Size (mm):	1.5	1.5~2.0	1.0	>1.0	1.0			
Metamorphic Classification:	I.C	IV.A.1	IV.A.2 ----->					
Temperature (°C):	+2.0	-7.0	-9.0	-9.0	-10.0	-10.0	-10.0	
Stratification:					40~57 (hard ice)			

Notes: Sunny, no wind.
Good road condition for wheel vehicle.

Snow Pit Data from South Pole Station

Date: 9 January 1986

Time: 09:09

Location: South Pole Station skiway, 3000 ft. marker (most frequent aircraft touchdown point).

Observer: S. M. Lee **Recorder:** S. M. Lee

Surface Crystal Size (mm): 0.3

Surface Density (g/cm^3): 0.27

Depth (cm)	0	10	20	30	40	50	60	70
Density (g/cm^3):	0.27	0.38	0.37	0.37	0.37	0.34	0.38	
Grain Size (mm):	0.3	<0.5	0.5	<1.0	1.0	1.0	1.0	
Metamorphic Classification:	II.A.1	II.B.1	---------->					
Temperature (°C):	-25	-27	-29	-31	-31	-32	-34	

Stratification: None

Notes: Uniformly overcast sky, slight wind.
Very dry snow, no adhesion or cohesion.

Snow Pit Data from South Pole Station

Date: 9 January 1986

Time: 13:55

Location: South Pole Station skiway, 6000 ft. marker (close to the turn-off point to taxiway).

Observer: S. M. Lee **Recorder:** S. M. Lee

Surface Crystal Size (mm): 0.25

Surface Density (g/cm^3): 0.32

Depth (cm)	0	10	20	30	40	50	60	70
Density (g/cm^3):	0.32	0.34	0.42	0.44	0.46	0.40		
Grain Size (mm):	0.25	0.5	<0.75	----->	<0.5	0.5		
Metamorphic Classification:	II.A.1	---->	II.B.1	----------	>			
Temperature (°C):	-24	-25	-28	-32	-31	-32		

Stratification: None

Notes: Uniformly overcast sky, slight wind.
Very dry snow, no adhesion or cohesion.

APPENDIX B: RAMMSONDE AND CLEGG TEST DATA, MCMURDO AND SOUTH POLE STATIONS

RAMMSONDE AND CLEGG RESULTS AT MCMURDO

As described previously, Rammsonde profiles were taken on the Shuttle Road, on the Delta Road, and on the Williams Field aircraft skiway. The general locations are shown in Figure 1, while Figure 2 shows the locations along the Shuttle and Delta Roads in somewhat more detail.

This section presents the Rammsonde results, including the field data as well as the computed Ramm value R along with a graphic presentation of the results. In general, the data sheets with completed calculations for a related group, such as all five profiles from station "20 MPH" (sign) are grouped in order, followed by the five profiles portrayed graphically on a single page. This arrangement is then repeated for succeeding stations or other logical groupings. Each data sheet is identified by the station or location, e.g. "Station 32 east," surface description (actually a *position*, such as 10 ft right), the date and the cone angle (either 60 or 30 *degrees*).

The Ramm hardness value for the standard 60° cone is based on the equation:

$$R = \frac{WHn}{X} + (W+Q)$$

where R = Ramm hardness (kgf)
W = weight of driving hammers (kg)
H = height of fall of hammer (cm)
n = number of hammer blows
X = depth of penetration after n blows (cm)
Q = weight of penetrometer (kg).

To develop correct values for the Rammsonde profiles for both McMurdo and the South Pole, corrections were applied to the Rammsonde hardness values for the first 10 cm of penetration. These are to compensate for the low penetration resistance when the point of the cone first enters the snow. Thus, the following corrections were made to the R values obtained in the first 10 cm of penetration for both the 30° and 60°cones (Niedringhaus 1965):

		Cone angle (degrees)	
		30	60
X = 0–5 cm	R_c =	$4.0R$	$4.7R$
X = 5–10 cm	R_c =	$1.6R$	$1.6R$
X = 0–10 cm	R_c =	$2.8R$	$3.0R$

where R = uncorrected Ramm value
X = depth of penetration after n blows (cm)
R_c = corrected Ramm resistance (kgf).

It should be noted that, for the 30° cone, the correction 2.8 for X = 0–10 cm was derived from averaging 4.0 and 1.6 for X = 0–5 cm and X = 5–10 cm, respectively. This was done because no correction factor for this range of X was available at the time of graph development. In addition, another correction factor was used for the 30° cone. After the first 10 cm of penetration, a correction coefficient of 2.0 was used to determine R_c (Niedringhaus 1965). Note: Since the preparation of this report, reanalysis of Niedringhaus's data has been done, which resulted in a correction factor of approximately 1.5, instead of 2. However, for the 60° cone, no additional factor is needed after the initial 10 cm of penetration.

These corrections are applied when Rammsonde has been placed on the snow surface and initial penetration of the cone has taken place. Thus the point of the cone after initial penetration becomes the datum for the first 10 cm of penetration and for the use of the correction factors. For the initial penetration, R is simply equal to $W+Q$.

Also included are two Rammsonde profiles taken on the edge of the Shuttle Road. These two were taken with the 30° cone.

RAMMSONDE DATA AND GRAPHIC PROFILES

Shuttle Road, McMurdo to Williams Field (or "Willy")
(Stations: 20 MPH sign (two dates), 32 east, 45 east, 105 east, 195 east)

FILENAME	: B:S20M10R.J07	TIME	:
LOCATION	: 20 MPH	SNOW TEMPERATURE	: -4.2
SURFACE DESCRIPTION	: 10 RIGHT	AIR TEMPERATURE	: +0.8
DATE	: 1/07/86	CONE TYPE	: 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	3	0	0	5.62	6
3	50	5	8	5	150	5.62	731
3	50	5	13	5	150	5.62	249
3	50	3	18	5	90	5.62	96
3	50	2	23	5	60	5.62	66
3	50	4	28	5	120	5.62	126
3	50	5	33	5	150	5.62	156
3	50	4	38	5	120	5.62	126
3	50	4	43	5	120	5.62	126
3	50	4	48	5	120	5.62	126
3	50	12	53	5	360	5.62	366
3	50	12	58	5	360	5.62	366
3	50	24	63	5	720	5.62	726

FILENAME : B:S20M20R.J07

LOCATION : 20 MPH

SURFACE DESCRIPTION : 20' RIGHT

DATE : 1/07/86

TIME : 15:40

SNOW TEMPERATURE : -4.7

AIR TEMPERATURE : -0.2

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	3	0	0	5.62	6
3	50	2	8	5	60	5.62	308
3	50	3	13	5	90	5.62	153
3	50	4	18	5	120	5.62	126
3	50	2	23	5	60	5.62	66
3	50	2	28	5	60	5.62	66
3	50	5	33	5	150	5.62	156
3	50	8	38	5	240	5.62	246
3	50	5	43	5	150	5.62	156
3	50	6	48	5	180	5.62	186
3	50	42	53	5	1260	5.62	1266

FILENAME : B:S20M30R.J07

LOCATION : 20 MPH

SURFACE DESCRIPTION : 30' RIGHT

DATE : 1/07/86

TIME :

SNOW TEMPERATURE : -4.0

AIR TEMPERATURE : +0.2

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	3	0	0	5.62	6
3	50	4	8	5	120	5.62	590
3	50	4	13	5	120	5.62	201
3	50	4	18	5	120	5.62	126
3	50	16	23	5	480	5.62	486
3	50	22	28	5	660	5.62	666
3	50	11	33	5	330	5.62	336
3	50	12	38	5	360	5.62	366
3	50	8	43	5	240	5.62	246
3	50	5	48	5	150	5.62	156
3	50	20	53	5	600	5.62	606
3	50	10	54	1	1500	5.62	1506

FILENAME : B:S20M40R.J07

LOCATION : 20 MPH

SURFACE DESCRIPTION : 40 RIGHT

DATE : 1/07/86

TIME : 16:12

SNOW TEMPERATURE : -4.2

AIR TEMPERATURE : -0.2

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	3	0	0	5.62	6
3	50	1	8	5	30	5.62	167
3	50	2	13	5	60	5.62	105
3	50	3	18	5	90	5.62	96
3	50	4	23	5	120	5.62	126
3	50	5	28	5	150	5.62	156
3	50	4	33	5	120	5.62	126
3	50	5	38	5	150	5.62	156
3	50	7	43	5	210	5.62	216
3	50	5	48	5	150	5.62	156
3	50	30	53	5	900	5.62	906

FILENAME : B:S20M50R.J07

LOCATION : 20 MPH

SURFACE DESCRIPTION : 50.5 RIGHT

DATE : 1/07/86

TIME : 16:20

SNOW TEMPERATURE : -4.7

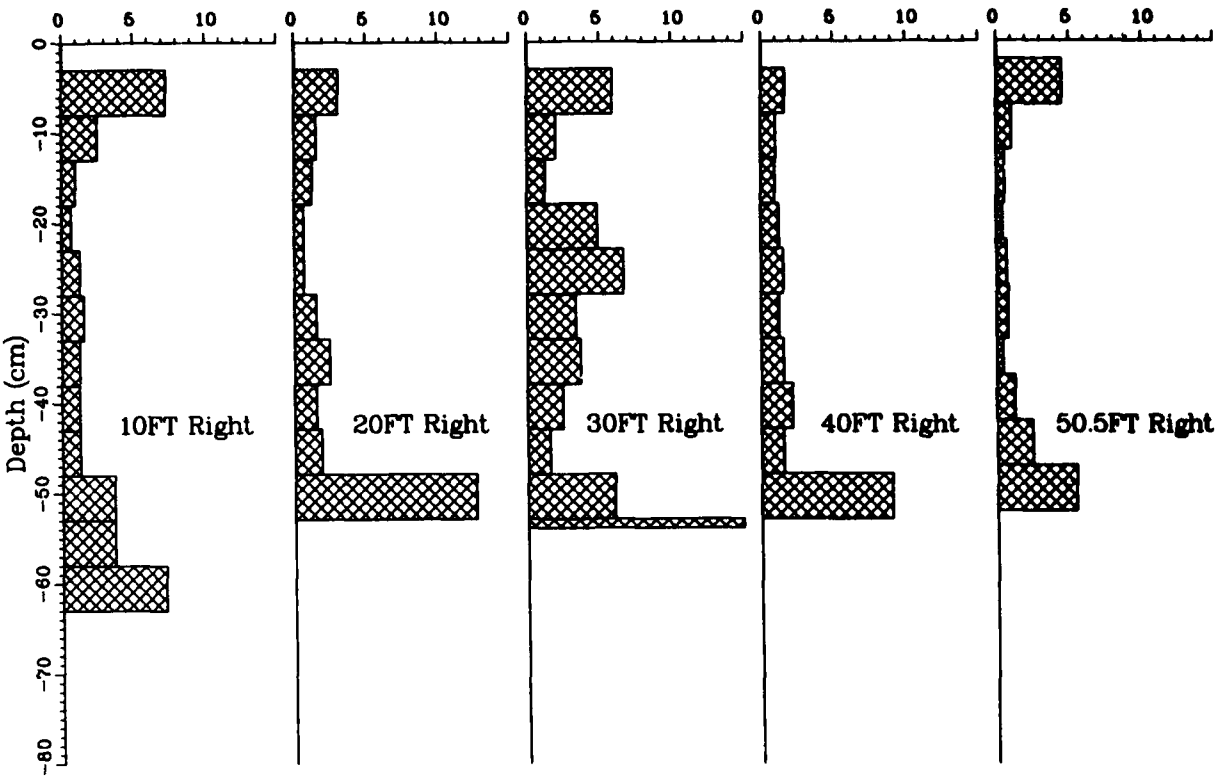
AIR TEMPERATURE :

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	2	0		5.62	6
3	50	3	7	5	90	5.62	449
3	50	2	12	5	60	5.62	105
3	50	2	18	6	50	5.62	56
3	50	1	22	4	37.5	5.62	43
3	50	2	27	5	60	5.62	66
3	50	3	33	6	75	5.62	81
3	50	1	37	4	37.5	5.62	43
3	50	4	42	5	120	5.62	126
3	50	8	47	5	240	5.62	246
3	50	18	52	5	540	5.62	546

WILLY FIELD SHUTTLE ROAD Station 20MPH 7 Jan, 1986

Rammsonde Values In Hundreds



FILENAME : B:S20M10R2.J08

LOCATION : 20 MPH

SURFACE DESCRIPTION : 10' RIGHT

DATE : 1/08/86

TIME : 9:50

SNOW TEMPERATURE : -8.3

AIR TEMPERATURE : -1.4

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	1	0	0	5.62	6
3	50	4	6	5	120	5.62	590
3	50	4	11	5	120	5.62	201
3	50	3	16	5	90	5.62	96
3	50	2	21	5	60	5.62	66
3	50	4	26	5	120	5.62	126
3	50	4	31	5	120	5.62	126
3	50	6	36	5	180	5.62	186
3	50	3	41	5	90	5.62	96
3	50	2	46	5	60	5.62	66
3	50	4	51	5	120	5.62	126
3	50	22	56	5	660	5.62	666
3	50	30	61	5	900	5.62	906

FILENAME : B:S20M20R2.J06

LOCATION : 20 MPH

SURFACE DESCRIPTION : 20 RIGHT

DATE : 1/08/86

TIME : 10:40

SNOW TEMPERATURE : -8.1

AIR TEMPERATURE :

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	1	0	0	5.62	6
3	50	2	6	5	60	5.62	306
3	50	3	11	5	90	5.62	153
3	50	4	16	5	120	5.62	126
3	50	4	21	5	120	5.62	126
3	50	3	26	5	90	5.62	96
3	50	2	31	5	60	5.62	66
3	50	8	36	5	240	5.62	246
3	50	6	41	5	180	5.62	186
3	50	4	46	5	120	5.62	126
3	50	20	51	5	600	5.62	606

FILENAME : B:S20M30R2.J06

LOCATION : 20 MPH

SURFACE DESCRIPTION : 30' RIGHT

DATE : 1/08/86

TIME : 10:54

SNOW TEMPERATURE : -7.9

AIR TEMPERATURE : -2.0

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	2	0	0	5.62	6
3	50	4	7	5	120	5.62	590
3	50	6	12	5	180	5.62	297
3	50	6	17	5	180	5.62	186
3	50	8	22	5	240	5.62	246
3	50	7	27	5	210	5.62	216
3	50	6	32	5	180	5.62	186
3	50	10	37	5	300	5.62	306
3	50	10	42	5	300	5.62	306
3	50	7	47	5	210	5.62	216
3	50	24	52	5	720	5.62	726

FILENAME : B:S20M40R2.J06

LOCATION : 20 MPH

SURFACE DESCRIPTION : 40' RIGHT

DATE : 1/08/86

TIME : 11:01

SNOW TEMPERATURE : -8.0

AIR TEMPERATURE : -0.1

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	1	0	0	5.62	6
3	50	3	6	5	90	5.62	449
3	50	6	11	5	180	5.62	297
3	50	5	16	5	150	5.62	156
3	50	5	21	5	150	5.62	156
3	50	4	26	5	120	5.62	126
3	50	10	31	5	300	5.62	306
3	50	7	36	5	210	5.62	216
3	50	5	41	5	150	5.62	156
3	50	4	46	5	120	5.62	126
3	50	6	51	5	180	5.62	186
3	50	20	54	3	1000	5.62	1006

FILENAME : B:S20M50R2.J08

LOCATION : 20 MPH

SURFACE DESCRIPTION : 50.5' RIGHT

DATE : 1/08/86

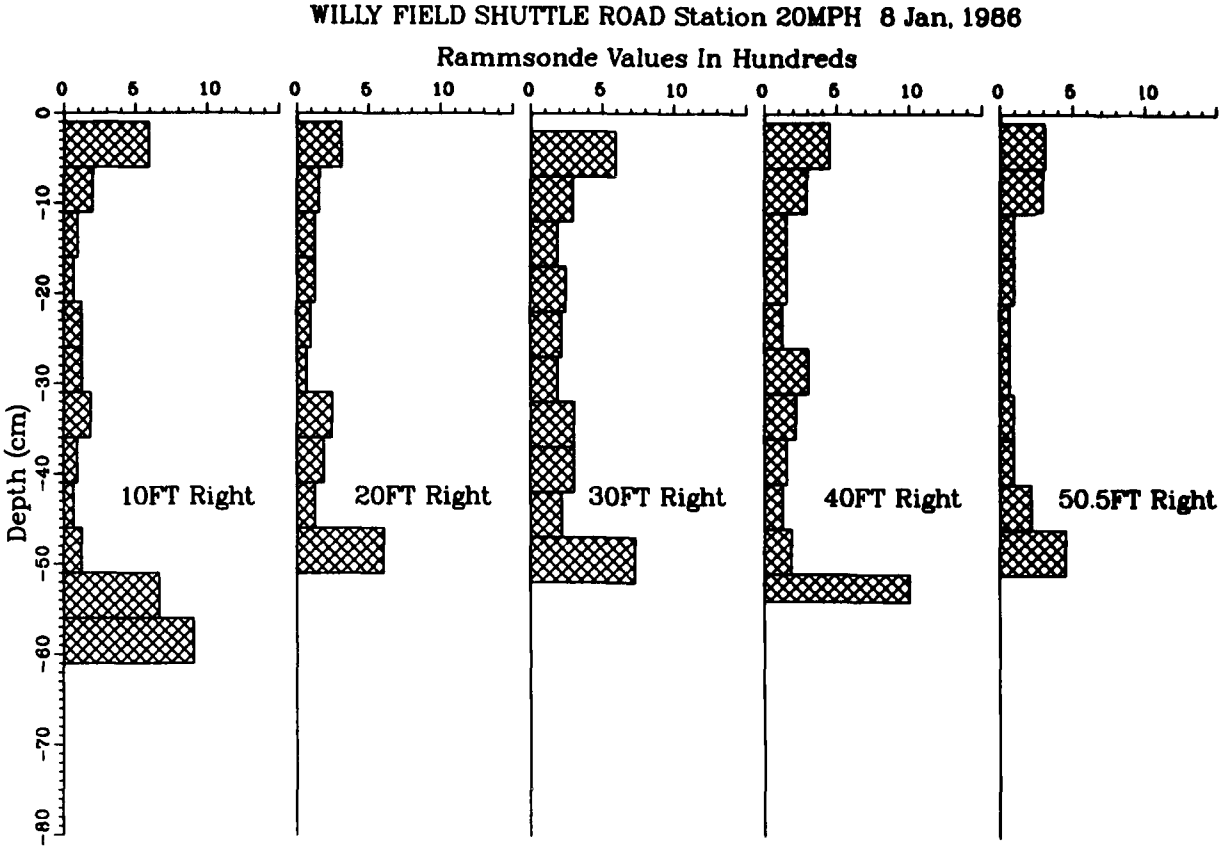
TIME : 11:11

SNOW TEMPERATURE : -7.2

AIR TEMPERATURE : -2.3

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	1	0	0	5.62	6
3	50	2	6	5	60	5.62	308
3	50	6	11	5	180	5.62	297
3	50	3	16	5	90	5.62	96
3	50	3	21	5	90	5.62	96
3	50	2	26	5	60	5.62	66
3	50	2	31	5	60	5.62	66
3	50	3	36	5	90	5.62	96
3	50	3	41	5	90	5.62	96
3	50	7	46	5	210	5.62	216
3	50	15	51	5	450	5.62	456


WILLY FIELD SHUTTLE ROAD Station 20MPH 8 Jan, 1986
Rammsonde Values In Hundreds
Depth (cm)
0
-10
-20
-30
-40
-50
-60
-70
-80
0
5
10
10FT Right
20FT Right
30FT Right
40FT Right
50.5FT Right

FILENAME : B:S32E10R.JOB

LOCATION : STATION 32 EAST

SURFACE DESCRIPTION : 10' RIGHT

DATE : 1/08/86

TIME : 14:20

SNOW TEMPERATURE : -6.0

AIR TEMPERATURE : -0.1

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	2	0	0	5.62	6
3	50	3	7	5	90	5.62	449
3	50	5	12	5	150	5.62	249
3	50	2	17	5	60	5.62	66
3	50	3	22	5	90	5.62	96
3	50	5	27	5	150	5.62	156
3	50	5	32	5	150	5.62	156
3	50	3	37	5	90	5.62	96
3	50	2	45	8	37.5	5.62	43
3	50	1	47	2	75	5.62	81
3	50	9	52	5	270	5.62	276
3	50	14	57	5	420	5.62	426
3	50	11	62	5	330	5.62	336
3	50	10	67	5	300	5.62	306
3	50	8	72	5	240	5.62	246

FILENAME : B:S32E20R.J08

LOCATION : STATION 32 EAST

SURFACE DESCRIPTION : 20' RIGHT

DATE : 1/08/86

TIME : 14:40

SNOW TEMPERATURE : -6.0

AIR TEMPERATURE : 0.0

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	2	0	0	5.62	6
3	50	4	7	5	120	5.62	590
3	50	11	12	5	330	5.62	537
3	50	8	17	5	240	5.62	246
3	50	6	22	5	180	5.62	186
3	50	5	27	5	150	5.62	156
3	50	6	32	5	180	5.62	186
3	50	4	37	5	120	5.62	126
3	50	7	42	5	210	5.62	216
3	50	9	47	5	270	5.62	276
3	50	5	52	5	150	5.62	156
3	50	26	57	5	780	5.62	786

FILENAME : B:S32E30R.J08

LOCATION : STATION 32 EAST

SURFACE DESCRIPTION : 30' RIGHT

DATE : 1/08/86

TIME : 14:48

SNOW TEMPERATURE : -6.0

AIR TEMPERATURE : 0.0

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	3	0	0	5.62	6
3	50	5	8	5	150	5.62	731
3	50	9	13	5	270	5.62	441
3	50	4	18	5	120	5.62	126
3	50	6	23	5	180	5.62	186
3	50	4	28	5	120	5.62	126
3	50	4	33	5	120	5.62	126
3	50	3	38	5	90	5.62	96
3	50	7	43	5	210	5.62	216
3	50	7	48	5	210	5.62	216
3	50	15	53	5	450	5.62	456

FILENAME : B:S32E40R.J06

LOCATION : STATION 32 EAST

SURFACE DESCRIPTION : 40' RIGHT

DATE : 1/08/86

TIME : 14:56

SNOW TEMPERATURE : -5.2

AIR TEMPERATURE : 0.0

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	2	0	0	5.62	6
3	50	3	7	5	90	5.62	449
3	50	10	12	5	300	5.62	489
3	50	6	17	5	180	5.62	186
3	50	4	22	5	120	5.62	126
3	50	2	28	6	50	5.62	56
3	50	1	32	4	37.5	5.62	43
3	50	4	37	5	120	5.62	126
3	50	3	42	5	90	5.62	96
3	50	3	48	6	75	5.62	81
3	50	8	52	4	300	5.62	306
3	50	10	53	1	1500	5.62	1506

FILENAME : B:S32E50R.J08

LOCATION : STATION 32 EAST

SURFACE DESCRIPTION : 50' RIGHT

DATE : 1/08/86

TIME : 15:05

SNOW TEMPERATURE : -6.0

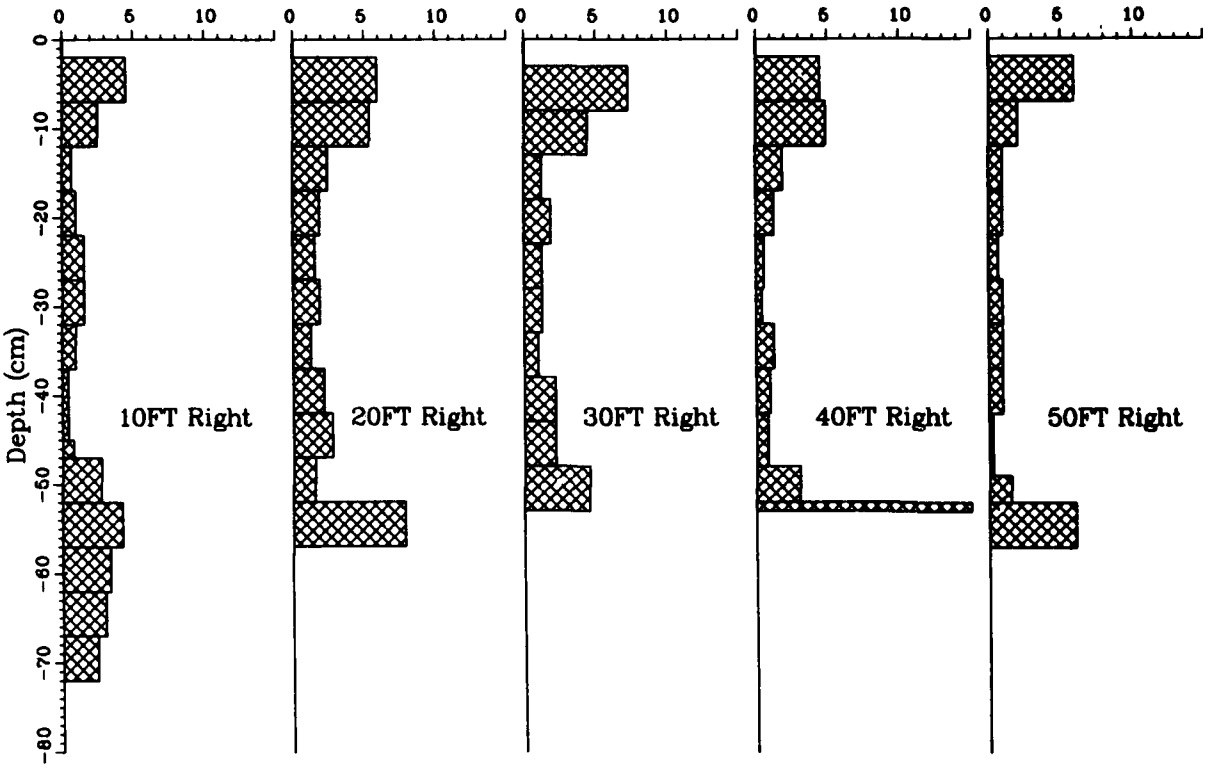
AIR TEMPERATURE : +0.3

CONE TYPE : 60

W	H	N	D	X'	W*H*N/X	W+Q	R
3	50	0	2	0	0	5.62	6
3	50	4	7	5	120	5.62	590
3	50	4	12	5	120	5.62	201
3	50	3	17	5	90	5.62	96
3	50	3	22	5	90	5.62	96
3	50	2	27	5	60	5.62	66
3	50	3	32	5	90	5.62	96
3	50	3	37	5	90	5.62	96
3	50	3	42	5	90	5.62	96
3	50	1	49	7	21.42857	5.62	27
3	50	3	52	3	150	5.62	156
3	50	20	57	5	600	5.62	606

WILLY FIELD SHUTTLE ROAD Station 32 East 8 Jan, 1986

Rammsonde Values In Hundreds



FILENAME : B:S45E10R.JOB

LOCATION : STATION 45 EAST

SURFACE DESCRIPTION : 10' RIGHT

DATE : 1/08/86

TIME : 16:10

SNOW TEMPERATURE : -5.9

AIR TEMPERATURE : +0.6

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	3	0	0	5.62	6
3	50	5	8	5	150	5.62	731
3	50	8	13	5	240	5.62	393
3	50	4	20	7	85.71429	5.62	91
3	50	1	23	3	50	5.62	56
3	50	5	28	5	150	5.62	156
3	50	4	33	5	120	5.62	126
3	50	4	38	5	120	5.62	126
3	50	5	43	5	150	5.62	156
3	50	4	48	5	120	5.62	126
3	50	2	53	5	60	5.62	66
3	50	22	58	5	660	5.62	666

FILENAME : B:S45E20R.JOB

LOCATION : STATION 45 EAST

SURFACE DESCRIPTION : 19.5' RIGHT

DATE : 1/08/86

TIME : 16:21

SNOW TEMPERATURE : -5.9

AIR TEMPERATURE : 0.0

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	3.5	0	0	5.62	6
3	50	2	8	4.5	66.66666	5.62	340
3	50	4	13	5	120	5.62	201
3	50	5	18	5	150	5.62	156
3	50	5	23	5	150	5.62	156
3	50	7	28	5	210	5.62	216
3	50	4	33	5	120	5.62	126
3	50	5	38	5	150	5.62	156
3	50	7	43	5	210	5.62	216
3	50	4	48	5	120	5.62	126
3	50	6	53	5	180	5.62	186
3	50	30	58	5	900	5.62	906

FILENAME : B:S45E32R.JOB

LOCATION : STATION 45 EAST

SURFACE DESCRIPTION : 32' RIGHT

DATE : 1/08/86

TIME : 16:28

SNOW TEMPERATURE : -5.5

AIR TEMPERATURE : -0.1

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	2	0	0	5.62	6
3	50	6	8	6	150	5.62	467
3	50	8	13	5	240	5.62	246
3	50	13	18	5	390	5.62	396
3	50	6	23	5	180	5.62	186
3	50	9	28	5	270	5.62	276
3	50	9	33	5	270	5.62	276
3	50	9	38	5	270	5.62	276
3	50	8	43	5	240	5.62	246
3	50	4	48	5	120	5.62	126
3	50	5	53	5	150	5.62	156
3	50	14	55	2	1050	5.62	1056

FILENAME : B:S45E45R.JOB

LOCATION : STATION 45 EAST

SURFACE DESCRIPTION : 45' RIGHT

DATE : 1/08/86

TIME : 16:36

SNOW TEMPERATURE : -4.8

AIR TEMPERATURE : +0.1

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	3	0	0	5.62	6
3	50	4	8	5	120	5.62	590
3	50	3	13	5	90	5.62	153
3	50	4	18	5	120	5.62	126
3	50	2	23	5	60	5.62	66
3	50	3	28	5	90	5.62	96
3	50	2	33	5	60	5.62	66
3	50	2	38	5	60	5.62	66
3	50	1	44	6	25	5.62	31
3	50	2	48	4	75	5.62	81
3	50		51	3	300	5.62	306
3	50	7	52	1	1050	5.62	1056

FILENAME : B:S45E52R.JOB

LOCATION : STATION 45 EAST

SURFACE DESCRIPTION : 52' RIGHT

DATE : 1/08/86

TIME : 16:42

SNOW TEMPERATURE : -4.5

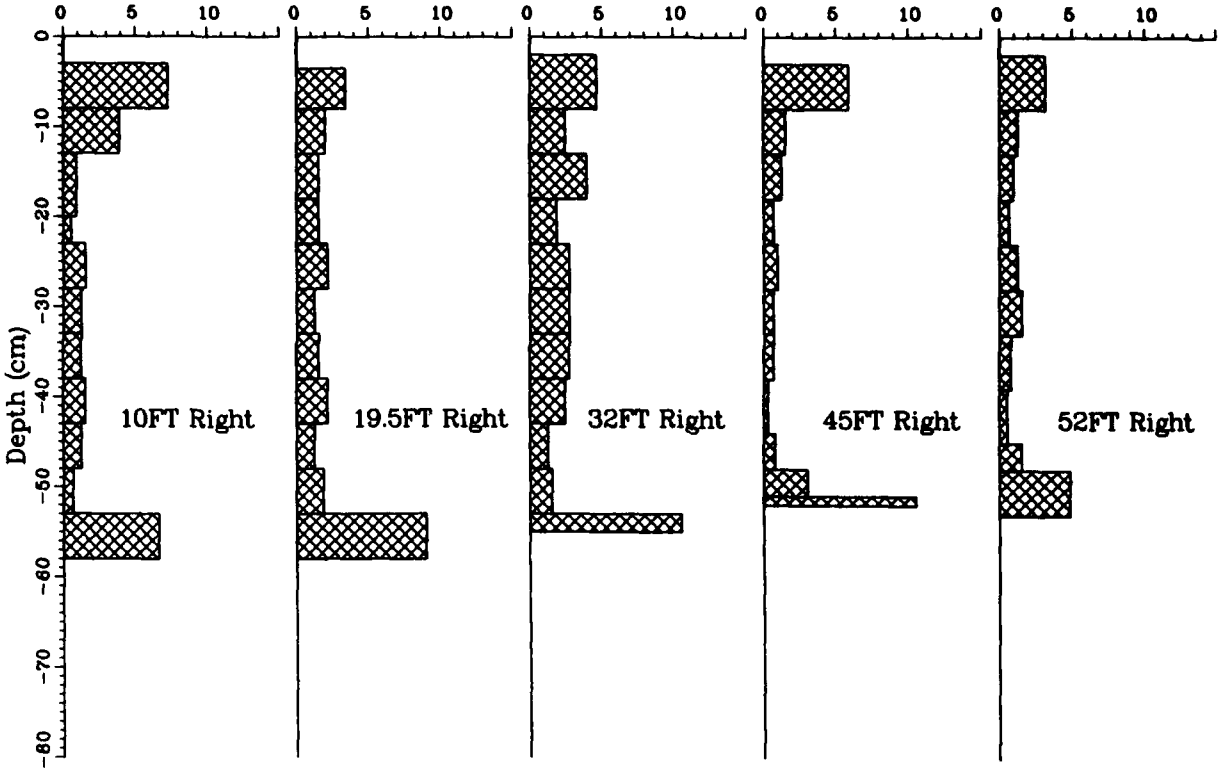
AIR TEMPERATURE : +0.1

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	2	0	0	5.62	6
3	50	4	8	6	100	5.62	317
3	50	4	13	5	120	5.62	126
3	50	3	18	5	90	5.62	96
3	50	2	23	5	60	5.62	66
3	50	4	28	5	120	5.62	126
3	50	5	33	5	150	5.62	156
3	50	3	39	6	75	5.62	81
3	50	2	45	6	50	5.62	56
3	50	3	48	3	150	5.62	156
3	50	16	53	5	480	5.62	486

WILLY FIELD SHUTTLE ROAD Station 45 East 8 Jan, 1986

Rammsonde Values In Hundreds



FILENAME : B:S105E10R.J09

LOCATION : STATION 105

SURFACE DESCRIPTION : 10' RIGHT

DATE : 1/09/86

TIME : 15:10

SNOW TEMPERATURE : -4.2

AIR TEMPERATURE : -2.2

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	3	0	0	5.62	6
3	50	4	8	5	120	5.62	590
3	50	4	13	5	120	5.62	201
3	50	5	18	5	150	5.62	156
3	50	5	23	5	150	5.62	156
3	50	4	28	5	120	5.62	126
3	50	2	33	5	60	5.62	66
3	50	5	38	5	150	5.62	156
3	50	4	43	5	120	5.62	126
3	50	3	48	5	90	5.62	96
3	50	5	53	5	150	5.62	156
3	50	18	58	5	540	5.62	546

FILENAME : B:S105E20R.J09

LOCATION : STATION 105 EAST

SURFACE DESCRIPTION : 20' RIGHT

DATE : 1/09/86

TIME : 15:30

SNOW TEMPERATURE : -5.1

AIR TEMPERATURE : -2.1

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	3	0	0	5.62	6
3	50	2	8	5	60	5.62	308
3	50	4	13	5	120	5.62	201
3	50	3	18	5	90	5.62	96
3	50	2	23	5	60	5.62	66
3	50	3	28	5	90	5.62	96
3	50	4	33	5	120	5.62	126
3	50	4	38	5	120	5.62	126
3	50	7	43	5	210	5.62	216
3	50	9	48	5	270	5.62	276
3	50	4	53	5	120	5.62	126
3	50	14	57	4	525	5.62	531

FILENAME : B:S105E30R.J09

LOCATION : STATION 105 EAST

SURFACE DESCRIPTION : 30' RIGHT

DATE : 1/09/86

TIME : 15:38

SNOW TEMPERATURE : -4.5

AIR TEMPERATURE : -2.2

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	3	0	0	5.62	6
3	50	5	8	5	150	5.62	731
3	50	10	13	5	300	5.62	489
3	50	16	18	5	480	5.62	486
3	50	9	23	5	270	5.62	276
3	50	8	28	5	240	5.62	246
3	50	10	33	5	300	5.62	306
3	50	7	38	5	210	5.62	216
3	50	5	43	5	150	5.62	156
3	50	5	48	5	150	5.62	156
3	50	3	53	5	90	5.62	96
3	50	4	58	5	120	5.62	126
3	50	24	63	5	720	5.62	726

FILENAME : B:S105E40R.J04

LOCATION : STATION 105 EAST

SURFACE DESCRIPTION : 40' RIGHT

DATE : 1/09/86

TIME : 15:48

SNOW TEMPERATURE : -4.1

AIR TEMPERATURE : -1.8

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	3	0	0	5.62	6
3	50	4	8	5	120	5.62	590
3	50	7	13	5	210	5.62	345
3	50	5	18	5	150	5.62	156
3	50	4	23	5	120	5.62	126
3	50	2	28	5	60	5.62	66
3	50	5	33	5	150	5.62	156
3	50	5	38	5	150	5.62	156
3	50	5	43	5	150	5.62	156
3	50	6	48	5	180	5.62	186
3	50	17	53	5	510	5.62	516

FILENAME : B:S105E51R.J09

LOCATION : STATION 105 EAST

SURFACE DESCRIPTION : 51' RIGHT

DATE : 1/09/86

TIME : 15:55

SNOW TEMPERATURE : -4.2

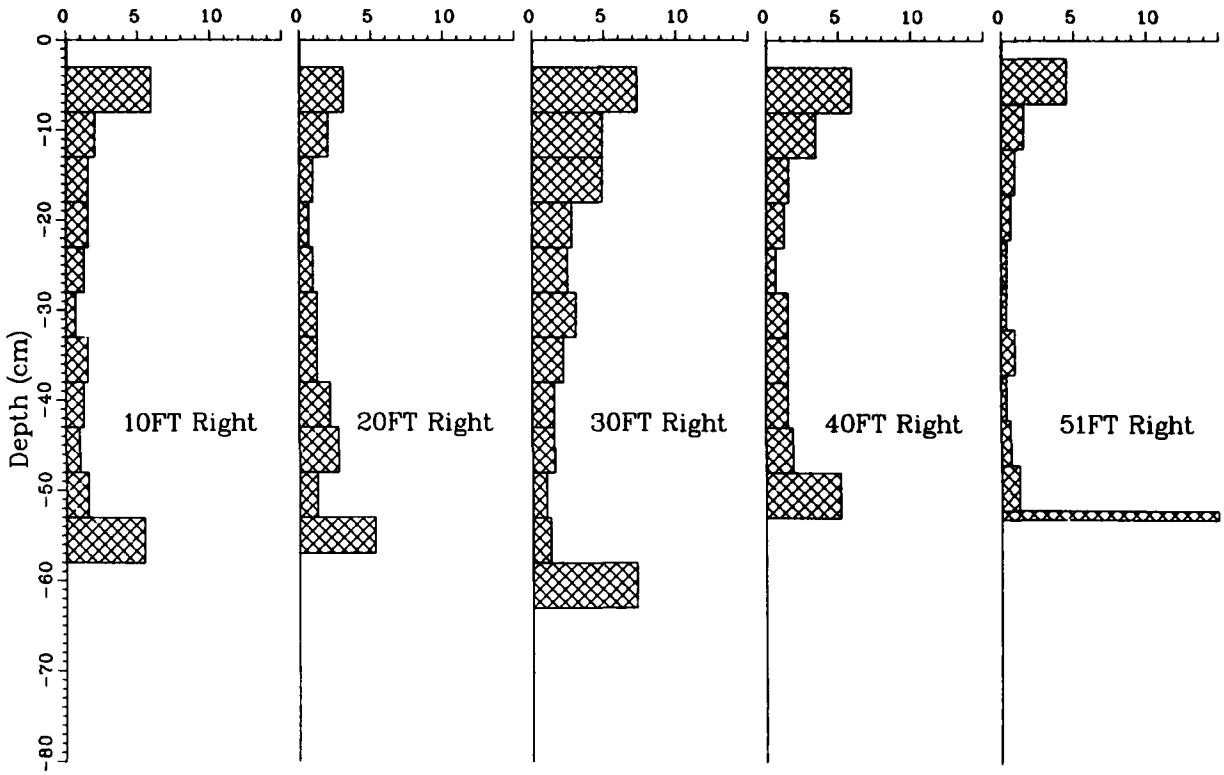
AIR TEMPERATURE : -2.1

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	2	0	0	5.62	6
3	50	3	7	5	90	5.62	449
3	50	3	12	5	90	5.62	153
3	50	3	17	5	90	5.62	96
3	50	2	22	5	60	5.62	66
3	50	1	27	5	30	5.62	36
3	50	1	32	5	30	5.62	36
3	50	3	37	5	90	5.62	96
3	50	1	42	5	30	5.62	36
3	50	2	47	5	60	5.62	66
3	50	4	52	5	120	5.62	126
3	50	10	53	1	1500	5.62	1506

WILLY FIELD SHUTTLE ROAD Station 105 East 9 Jan, 1986

Rammsonde Values In Hundreds



FILENAME : B:S195E10R.J13

LOCATION : WILLY FIELD ROAD

SURFACE DESCRIPTION : 195 EAST 10' RIGHT

DATE : 1/13/86

TIME : 9:55

SNOW TEMPERATURE : -9.0

AIR TEMPERATURE : -5.6

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	1	0	0	5.62	6
3	50	6	6	5	180	5.62	872
3	50	6	11	5	180	5.62	297
3	50	5	16	5	150	5.62	156
3	50	2	21	5	60	5.62	66
3	50	2	25	4	75	5.62	81
3	50	3	31	6	75	5.62	81
3	50	5	36	5	150	5.62	156
3	50	2	41	5	60	5.62	66
3	50	2	46	5	60	5.62	66
3	50	2	51	5	60	5.62	66
3	50	5	56	5	150	5.62	156
3	50	14	61	5	420	5.62	426

FILENAME : B:S195E20R.J13

LOCATION : WILLY FIELD ROAD

SURFACE DESCRIPTION : 195 EAST 20' RIGHT

DATE : 1/13/86

TIME : 10:02

SNOW TEMPERATURE : -8.9

AIR TEMPERATURE : -4.6

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	1	0	0	5.62	6
3	50	5	6	5	150	5.62	731
3	50	12	11	5	360	5.62	585
3	50	5	16	5	150	5.62	156
3	50	3	21	5	90	5.62	96
3	50	5	26	5	150	5.62	156
3	50	4	31	5	120	5.62	126
3	50	5	36	5	150	5.62	156
3	50	6	41	5	180	5.62	186
3	50	8	46	5	240	5.62	246
3	50	4	51	5	120	5.62	126
3	50	15	56	5	450	5.62	456

FILENAME : B:S195E30R.J13

LOCATION : WILLY FIELD ROAD

SURFACE DESCRIPTION : 195 EAST 30' RIGHT

DATE : 1/13/86

TIME :

SNOW TEMPERATURE : -8.9

AIR TEMPERATURE : -4.7

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	3	0	0	5.62	6
3	50	9	8	5	270	5.62	1295
3	50	17	13	5	510	5.62	825
3	50	10	18	5	300	5.62	306
3	50	5	23	5	150	5.62	156
3	50	6	28	5	180	5.62	186
3	50	12	33	5	360	5.62	366
3	50	6	38	5	180	5.62	186
3	50	8	43	5	240	5.62	246
3	50	6	48	5	180	5.62	186
3	50	3	53	5	90	5.62	96
3	50	15	58	5	450	5.62	456

FILENAME : B:S195E45R.J13

LOCATION : WILLY FIELD ROAD

SURFACE DESCRIPTION : 195 EAST 40' RIGHT

DATE : 1/13/86

TIME : 10:46

SNOW TEMPERATURE : -8.6

AIR TEMPERATURE : -4.0

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+0	R
3	50	0	3	0	0	5.62	0
3	50	8	8	5	240	5.62	1154
3	50	12	13	5	360	5.62	985
3	50	4	18	5	120	5.62	126
3	50	6	23	5	180	5.62	186
3	50	4	28	5	120	5.62	126
3	50	5	33	5	150	5.62	156
3	50	3	38	5	90	5.62	96
3	50	1	42	4	37.5	5.62	43
3	50	3	48	6	75	5.62	81
3	50	4	53	5	120	5.62	126
3	50	12	56	3	600	5.62	606

FILENAME : B:S195E50R.J13

LOCATION : WILLY FIELD ROAD

SURFACE DESCRIPTION : 195 EAST 50' RIGHT

DATE : 1/13/86

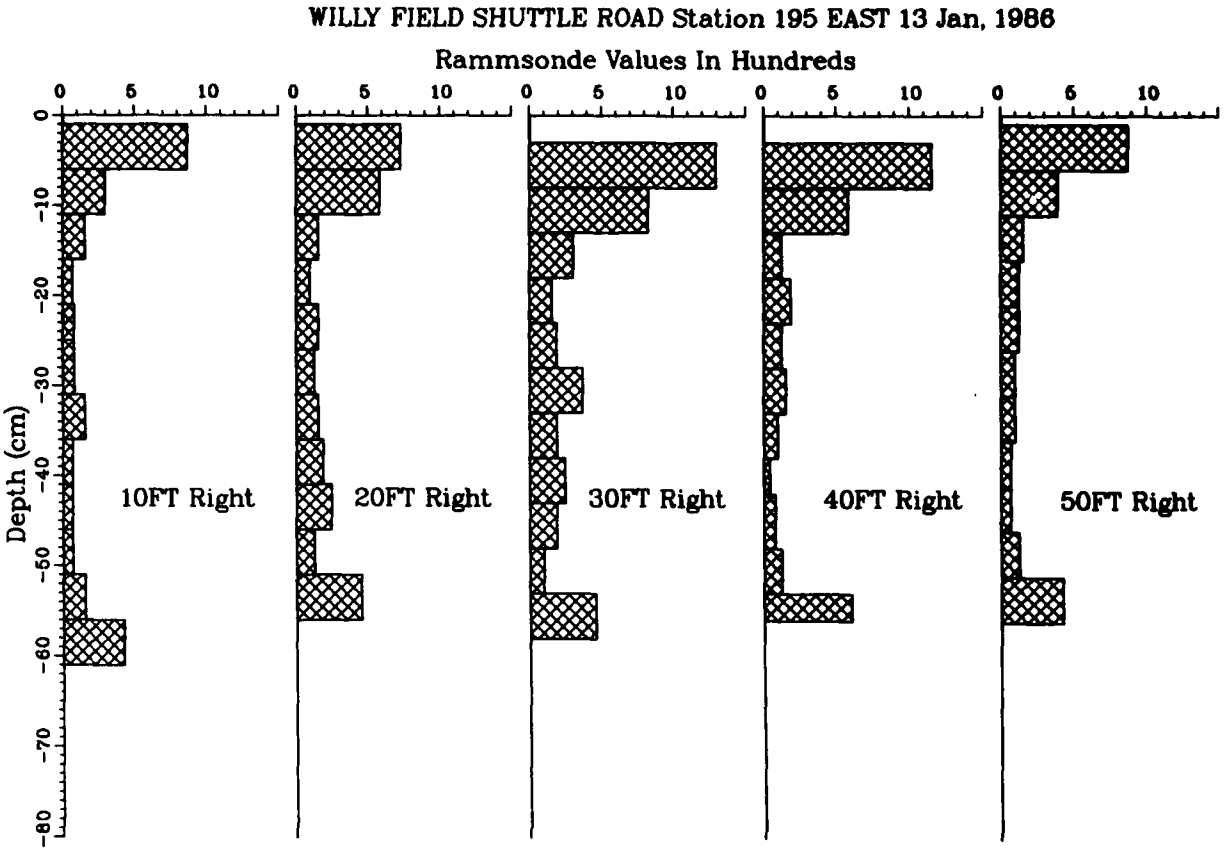
TIME : 10:57

SNOW TEMPERATURE : -8.9

AIR TEMPERATURE : -2.4

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+0	R
3	50	0	1	0	0	5.62	0
3	50	6	6	5	180	5.62	872
3	50	8	11	5	240	5.62	393
3	50	5	16	5	150	5.62	156
3	50	4	21	5	120	5.62	126
3	50	4	26	5	120	5.62	126
3	50	3	31	5	90	5.62	96
3	50	3	36	5	90	5.62	96
3	50	2	41	5	60	5.62	66
3	50	2	46	5	60	5.62	66
3	50	4	51	5	120	5.62	126
3	50	14	56	5	420	5.62	426


WILLY FIELD SHUTTLE ROAD Station 195 EAST 13 Jan, 1986
Rammsonde Values In Hundreds
Depth (cm)
0
-10
-20
-30
-40
-50
-60
-70
-80
0
5
10
10FT Right
20FT Right
30FT Right
40FT Right
50FT Right

RAMMSONDE DATA AND GRAPHIC PROFILES
Williams Field Skiway (Stations: 5/5, 6/4, 7/3, 8/2, and 9/1; all centerlines 5/5, 6/4, 7/3, 8/2, and 9/1).

FILE NAME : B:W5-5-C.J10
LOCATION : WILLY FIELD
SURFACE DESCRIPTION : 5/5 CL
DATE : 1/10/86
TIME : 16:08
SNOW TEMPERATURE : -4.6
AIR TEMPERATURE : -1.1
CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	1	0	0	5.62	6
3	50	2	6	5	60	5.62	308
3	50	5	11	5	150	5.62	249
3	50	4	16	5	120	5.62	126
3	50	6	21	5	180	5.62	186
3	50	4	26	5	120	5.62	126
3	50	3	31	5	90	5.62	96
3	50	3	36	5	90	5.62	96
3	50	2	41	5	60	5.62	66
3	50	2	46	5	60	5.62	66
3	50	3	51	5	90	5.62	96
3	50	10	56	5	300	5.62	306

FILENAME : B:W5-5-25R.J11

LOCATION : WILLY FIELD

SURFACE DESCRIPTION : 5/5 25' RIGHT

DATE : 1/11/86

TIME :

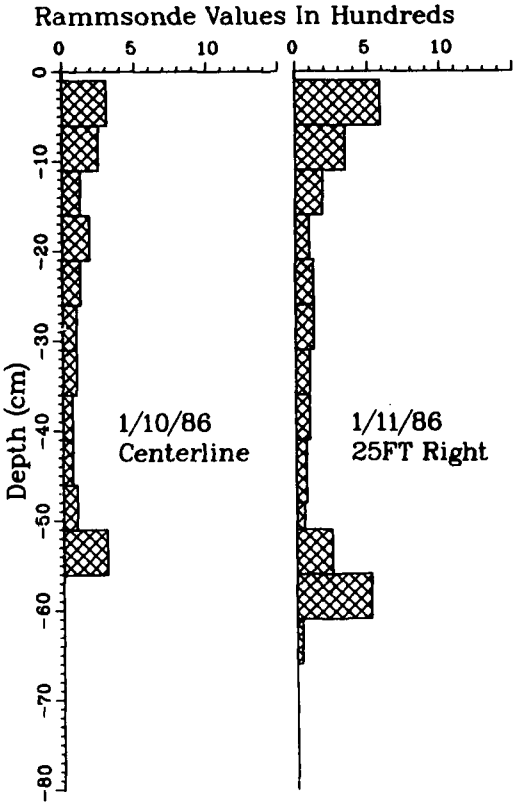
SNOW TEMPERATURE :

AIR TEMPERATURE :

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	1	0	0	5.62	6
3	50	4	6	5	120	5.62	590
3	50	7	11	5	210	5.62	345
3	50	6	16	5	180	5.62	186
3	50	3	21	5	90	5.62	96
3	50	4	26	5	120	5.62	126
3	50	4	31	5	120	5.62	126
3	50	3	36	5	90	5.62	96
3	50	3	41	5	90	5.62	96
3	50	3	48	7	64.28571	5.62	70
3	50	1	51	3	50	5.62	56
3	50	8	56	5	240	5.62	246
3	50	17	61	5	510	5.62	516
3	50	12	66	5	360	5.62	366

WILLY FIELD Station 5/5 Various Dates



FILENAME : B:W6-4-20L.J11

LOCATION : WILLY FIELD

SURFACE DESCRIPTION : 6/4 20' LEFT

DATE : 1/11/86

TIME : 14:36

SNOW TEMPERATURE : -4.8

AIR TEMPERATURE :

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	1	0	0	5.62	6
3	50	5	6	5	150	5.62	731
3	50	3	11	5	90	5.62	153
3	50	5	16	5	150	5.62	156
3	50	8	21	5	240	5.62	246
3	50	4	26	5	120	5.62	126
3	50	2	33	7	42.85715	5.62	48
3	50	1	36	3	50	5.62	56
3	50	2	41	5	60	5.62	66
3	50	2	45	4	75	5.62	81
3	50	8	51	6	200	5.62	206
3	50	10	53	2	750	5.62	756

FILENAME : B:W6-4-C.J10

LOCATION : WILLY FIELD

SURFACE DESCRIPTION : 6/4 CL

DATE : 1/10/86

TIME : 15:51

SNOW TEMPERATURE : -4.2

AIR TEMPERATURE : -1.2

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	1	0	0	5.62	6
3	50	3	6	5	90	5.62	449
3	50	6	11	5	180	5.62	297
3	50	3	16	5	90	5.62	96
3	50	1	21	5	30	5.62	36
3	50	4	26	5	120	5.62	126
3	50	4	31	5	120	5.62	126
3	50	3	36	5	90	5.62	96
3	50	2	41	5	60	5.62	66
3	50	2	46	5	60	5.62	66
3	50	7	50	4	262.5	5.62	268
3	50	6	51	1	900	5.62	906

FILENAME : B16-4-20R.J11

LOCATION : WILLY FIELD

SURFACE DESCRIPTION : 6/4 20' RIGHT

DATE : 1/11/86

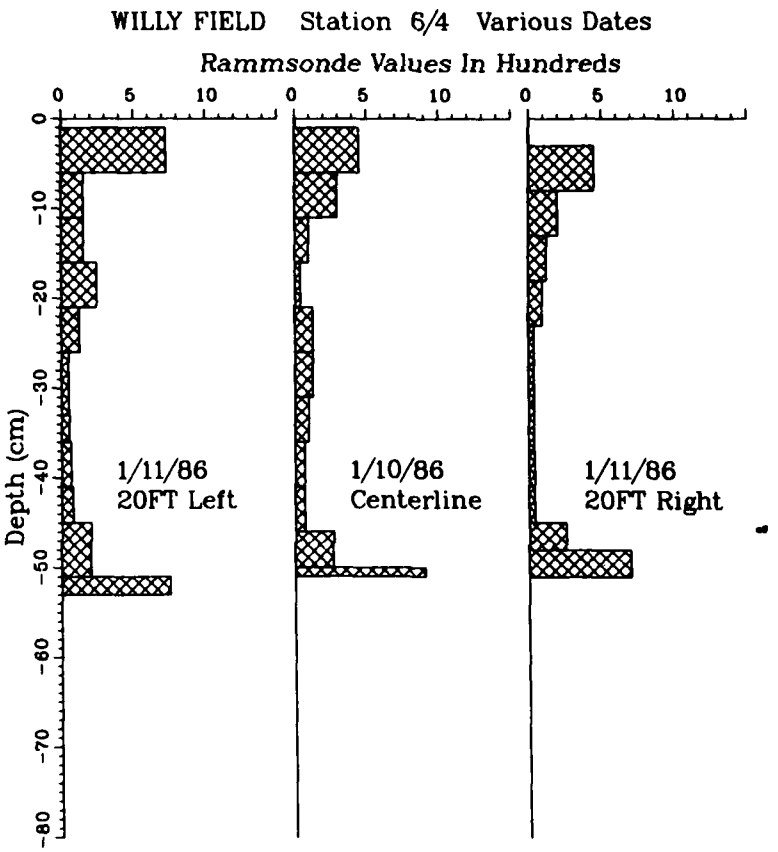
TIME : 14:27

SNOW TEMPERATURE : -5.6

AIR TEMPERATURE :

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W*Q	R
3	50	0	3	0	0	5.62	6
3	50	3	8	5	90	5.62	449
3	50	4	13	5	120	5.62	201
3	50	4	18	5	120	5.62	126
3	50	3	23	5	90	5.62	96
3	50	2	32	9	33.33333	5.62	39
3	50	1	37	5	30	5.62	36
3	50	1	41	4	37.5	5.62	43
3	50	1	45	4	37.5	5.62	43
3	50	5	48	3	250	5.62	256
3	50	14	51	3	700	5.62	706



FILENAME : B:W7-3-25L.J11

LOCATION : WILLY FIELD

SURFACE DESCRIPTION : 7/3 25' LEFT

DATE : 1/11/86

TIME : 14:03

SNOW TEMPERATURE : -4.8

AIR TEMPERATURE :

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+D	R
3	50	0	2	0	0	5.62	6
3	50	3	8	6	75	5.62	242
3	50	5	13	5	150	5.62	156
3	50	6	18	5	180	5.62	186
3	50	4	23	5	120	5.62	126
3	50	4	28	5	120	5.62	126
3	50	3	33	5	90	5.62	96
3	50	4	38	5	120	5.62	126
3	50	2	43	5	60	5.62	66
3	50	18	48	5	540	5.62	546

FILENAME : B:W7-3-C.J10

LOCATION : WILLY FIELD

SURFACE DESCRIPTION : 7/3 CL

DATE : 1/10/86

TIME : 15:36

SNOW TEMPERATURE : -4.5

AIR TEMPERATURE : -0.6

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+D	R
3	50	0	1	0	0	5.62	6
3	50	3	6	5	90	5.62	449
3	50	10	11	5	300	5.62	489
3	50	5	16	5	150	5.62	156
3	50	5	21	5	150	5.62	156
3	50	4	26	5	120	5.62	126
3	50	3	31	5	90	5.62	96
3	50	3	36	5	90	5.62	96
3	50	2	41	5	60	5.62	66
3	50	7	46	5	210	5.62	216
3	50	10	48	2	750	5.62	756

FILENAME : B:W7-3-25R.J11

LOCATION : WILLY FIELD

SURFACE DESCRIPTION : 7/3 25' RIGHT

DATE : 1/11/86

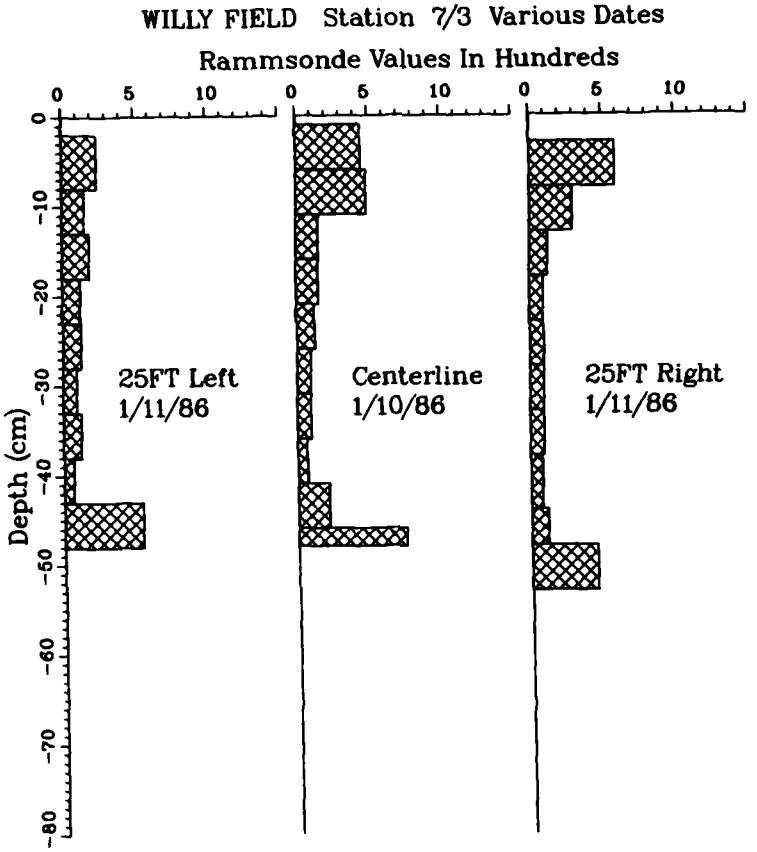
TIME : 13:54

SNOW TEMPERATURE : -4.8

AIR TEMPERATURE :

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	3	0	0	5.62	6
3	50	4	8	5	120	5.62	590
3	50	6	13	5	180	5.62	297
3	50	4	18	5	120	5.62	126
3	50	3	23	5	90	5.62	96
3	50	3	28	5	90	5.62	96
3	50	3	33	5	90	5.62	96
3	50	3	38	5	90	5.62	96
3	50	3	44	6	75	5.62	81
3	50	3	48	4	112.5	5.62	118
3	50	15	53	5	450	5.62	456

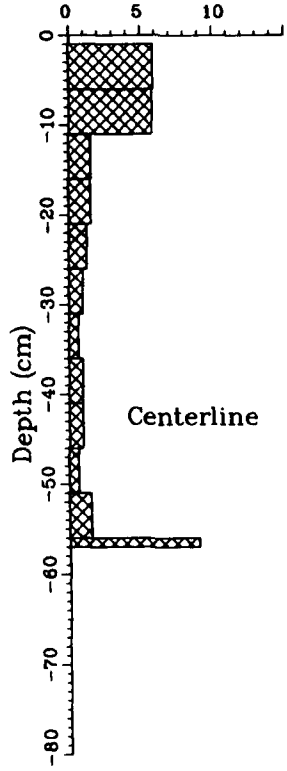


FILENAME	:	B:WB-2-C.J10
LOCATION	:	WILLY FIELD
SURFACE DESCRIPTION	:	8/2 CL
DATE	:	1/10/86
TIME	:	14:45
SNOW TEMPERATURE	:	-4.8
AIR TEMPERATURE	:	-2.3
CONE TYPE	:	60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	1	0	0	5.62	6
3	50	4	6	5	120	5.62	590
3	50	12	11	5	360	5.62	585
3	50	5	16	5	150	5.62	156
3	50	5	21	5	150	5.62	156
3	50	4	26	5	120	5.62	126
3	50	3	31	5	90	5.62	96
3	50	2	36	5	60	5.62	66
3	50	3	41	5	90	5.62	96
3	50	3	46	5	90	5.62	96
3	50	2	51	5	60	5.62	66
3	50	5	56	5	150	5.62	156
3	50	6	57	1	900	5.62	906

WILLY FIELD Station 8/2 10 Jan, 1986

Rammsonde Values In Hundreds



FILENAME : B:W9-1-80L.J10

LOCATION : WILLY FIELD

SURFACE DESCRIPTION : 9/1 80' LEFT

DATE : 1/10/86

TIME : 14:09

SNOW TEMPERATURE : -5.0

AIR TEMPERATURE : -2.1

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	3	0	0	5.62	6
3	50	2	9	6	50	5.62	167
3	50	1	13	4	37.5	5.62	69
3	50	1	20	7	21.42857	5.62	27
3	50	1	23	3	50	5.62	56
3	50	2	28	5	60	5.62	66
3	50	3	33	5	90	5.62	96
3	50	2	38	5	60	5.62	66
3	50	3	43	5	90	5.62	96
3	50	3	48	5	90	5.62	96
3	50	6	53	5	180	5.62	186
3	50	10	55	2	750	5.62	756

FILENAME : B:W9-1-20L.J10

LOCATION : WILLY FIELD

SURFACE DESCRIPTION : 9/1 20' LEFT

DATE : 1/10/86

TIME : 14:28

SNOW TEMPERATURE : -4.5

AIR TEMPERATURE : -3.4

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	1	0	0	5.62	6
3	50	3	6	5	90	5.62	449
3	50	7	11	5	210	5.62	345
3	50	6	16	5	180	5.62	186
3	50	5	21	5	150	5.62	156
3	50	6	26	5	180	5.62	186
3	50	5	31	5	150	5.62	156
3	50	5	36	5	150	5.62	156
3	50	3	41	5	90	5.62	96
3	50	3	46	5	90	5.62	96
3	50	3	51	5	90	5.62	96
3	50	10	56	5	300	5.62	306

FILENAME : B:W9-1-C.J10

LOCATION : WILLY FIELD

SURFACE DESCRIPTION : 9/1 CL

DATE : 1/10/86

TIME : 13:48

SNOW TEMPERATURE : -5.0

AIR TEMPERATURE : -2.1

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	1	0	0	5.62	6
3	50	4	6	5	120	5.62	590
3	50	6	11	5	180	5.62	297
3	50	13	16	5	390	5.62	396
3	50	9	21	5	270	5.62	276
3	50	4	26	5	120	5.62	126
3	50	4	31	5	120	5.62	126
3	50	4	36	5	120	5.62	126
3	50	4	41	5	120	5.62	126
3	50	4	46	5	120	5.62	126
3	50	4	51	5	120	5.62	126
3	50	7	56	5	210	5.62	216
3	50	24	60	4	900	5.62	906

FILENAME : B:W9-1-20R.J10

LOCATION : WILLY FIELD

SURFACE DESCRIPTION : 9/1 20' RIGHT

DATE : 1/10/86

TIME : 14:19

SNOW TEMPERATURE : -5.0

AIR TEMPERATURE : -1.2

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	1	0	0	5.62	6
3	50	3	6	5	90	5.62	449
3	50	3	11	5	90	5.62	153
3	50	3	16	5	90	5.62	96
3	50	3	21	5	90	5.62	96
3	50	3	26	5	90	5.62	96
3	50	3	31	5	90	5.62	96
3	50	3	36	5	90	5.62	96
3	50	2	43	7	42.85715	5.62	48
3	50	1	48	5	30	5.62	36
3	50	1	51	3	50	5.62	56
3	50	10	54	3	500	5.62	506

FILENAME : B:W9-1-80R.J10

LOCATION : WILLY FIELD

SURFACE DESCRIPTION : 9/1 80' RIGHT

DATE : 1/10/86

TIME : 13:58

SNOW TEMPERATURE : -4.9

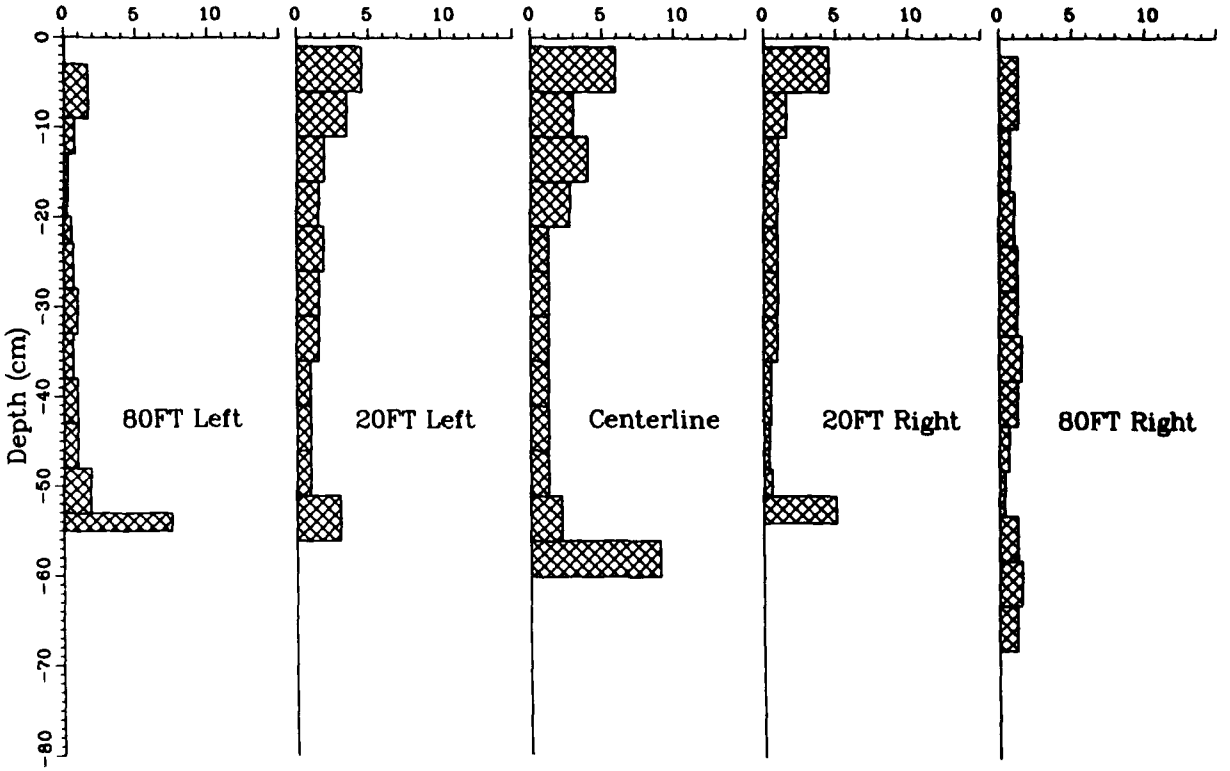
AIR TEMPERATURE : -2.2

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	2	0	0	5.62	6
3	50	2	10	8	37.5	5.62	129
3	50	3	17	7	64.28571	5.62	70
3	50	4	23	6	100	5.62	106
3	50	4	28	5	120	5.62	126
3	50	4	33	5	120	5.62	126
3	50	5	38	5	150	5.62	156
3	50	4	43	5	120	5.62	126
3	50	2	48	5	60	5.62	66
3	50	1	53	5	30	5.62	36
3	50	4	58	5	120	5.62	126
3	50	5	63	5	150	5.62	156
3	50	4	68	5	120	5.62	126

WILLY FIELD Station 9/1 10 Jan, 1986

Rammsonde Values In Hundreds



FILENAME : B:W5-5-C.J10

LOCATION : WILLY FIELD

SURFACE DESCRIPTION : 5/5 CL

DATE : 1/10/86

TIME : 16:08

SNOW TEMPERATURE : -4.6

AIR TEMPERATURE : -1.1

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+D	R
3	50	0	1	0	0	5.62	6
3	50	2	6	5	60	5.62	308
3	50	5	11	5	150	5.62	249
3	50	4	16	5	120	5.62	126
3	50	6	21	5	180	5.62	186
3	50	4	26	5	120	5.62	126
3	50	3	31	5	90	5.62	96
3	50	3	36	5	90	5.62	96
3	50	2	41	5	60	5.62	66
3	50	2	46	5	60	5.62	66
3	50	3	51	5	90	5.62	96
3	50	10	56	5	300	5.62	306

FILE NAME : B:W6-4-C.J10

LOCATION : WILLY FIELD

SURFACE DESCRIPTION : 6/4 CL

DATE : 1/10/86

TIME : 15:51

SNOW TEMPERATURE : -4.2

AIR TEMPERATURE : -1.2

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+D	R
3	50	0	1	0	0	5.62	6
3	50	3	6	5	90	5.62	449
3	50	6	11	5	180	5.62	297
3	50	3	16	5	90	5.62	96
3	50	1	21	5	30	5.62	36
3	50	4	26	5	120	5.62	126
3	50	4	31	5	120	5.62	126
3	50	3	36	5	90	5.62	96
3	50	2	41	5	60	5.62	66
3	50	2	46	5	60	5.62	66
3	50	7	50	4	262.5	5.62	268
3	50	6	51	1	900	5.62	906

FILE NAME : B:W7-3-C.J10

LOCATION : WILLY FIELD

SURFACE DESCRIPTION : 7/3 CL

DATE : 1/10/86

TIME : 15:36

SNOW TEMPERATURE : -4.5

AIR TEMPERATURE : -0.6

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	1	0	0	5.62	6
3	50	3	6	5	90	5.62	449
3	50	10	11	5	300	5.62	489
3	50	5	16	5	150	5.62	156
3	50	5	21	5	150	5.62	156
3	50	4	26	5	120	5.62	126
3	50	3	31	5	90	5.62	96
3	50	3	36	5	90	5.62	96
3	50	2	41	5	60	5.62	66
3	50	7	46	5	210	5.62	216
3	50	10	48	2	750	5.62	756

FILE NAME : B:W8-2-C.J10

LOCATION : WILLY FIELD

SURFACE DESCRIPTION : 8/2 CL

DATE : 1/10/86

TIME : 14:45

SNOW TEMPERATURE : -4.8

AIR TEMPERATURE : -2.3

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	1	0	0	5.62	6
3	50	4	6	5	120	5.62	590
3	50	12	11	5	360	5.62	585
3	50	5	16	5	150	5.62	156
3	50	5	21	5	150	5.62	156
3	50	4	26	5	120	5.62	126
3	50	3	31	5	90	5.62	96
3	50	2	36	5	60	5.62	66
3	50	3	41	5	90	5.62	96
3	50	3	46	5	90	5.62	96
3	50	2	51	5	60	5.62	66
3	50	5	56	5	150	5.62	156
3	50	6	57	1	900	5.62	906

FILE NAME : B:W9-1-C.J10

LOCATION : WILLY FIELD

SURFACE DESCRIPTION : 9/1 CL

DATE : 1/10/86

TIME : 13:48

SNOW TEMPERATURE : -5.0

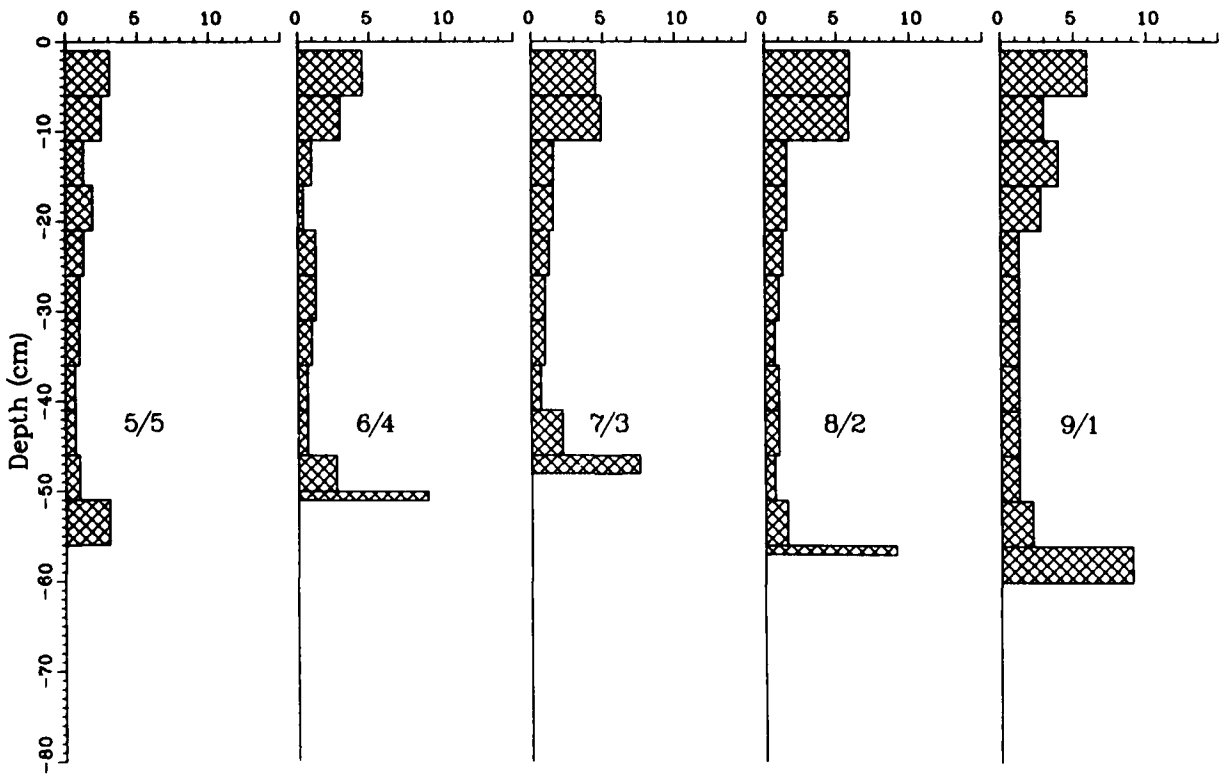
AIR TEMPERATURE : -2.1

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	1	0	0	5.62	6
3	50	4	6	5	120	5.62	590
3	50	6	11	5	180	5.62	297
3	50	13	16	5	390	5.62	396
3	50	9	21	5	270	5.62	276
3	50	4	26	5	120	5.62	126
3	50	4	31	5	120	5.62	126
3	50	4	36	5	120	5.62	126
3	50	4	41	5	120	5.62	126
3	50	4	46	5	120	5.62	126
3	50	4	51	5	120	5.62	126
3	50	7	56	5	210	5.62	216
3	50	24	60	4	900	5.62	906

WILLY FIELD Centerline 10 Jan, 1986

Rammsonde Values In Hundreds



RAMMSONDE DATA AND GRAPHIC PROFILES
Delta Road Centerline
(Stations: 20 MPH sign, 32 east, 45 east, 105 east, 195 east.)

FILENAME : B:D20M-C.J13

LOCATION : 20 MPH

SURFACE DESCRIPTION : CL OF DELTA ROAD 30 RIGHT

DATE : 1/13/86

TIME :

SNOW TEMPERATURE :

AIR TEMPERATURE :

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	3	0	0	5.62	6
3	50	7	8	5	210	5.62	1013
3	50	7	13	5	210	5.62	345
3	50	8	18	5	240	5.62	246
3	50	5	23	5	150	5.62	156
3	50	4	30	7	85.71429	5.62	91
3	50	4	39	9	66.66666	5.62	72
3	50	2	45	6	50	5.62	56
3	50	2	51	6	50	5.62	56
3	50	1	57	6	25	5.62	31
3	50	5	61	4	187.5	5.62	193
3	50	12	63	2	900	5.62	906

FILENAME : B:D32E-C.J13

LOCATION : 32 EAST

SURFACE DESCRIPTION : CL OF DELTA ROAD

DATE : 1/13/86

TIME :

SNOW TEMPERATURE :

AIR TEMPERATURE :

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	3	0	0	5.62	6
3	50	4	8	5	120	5.62	590
3	50	10	13	5	300	5.62	489
3	50	8	18	5	240	5.62	246
3	50	7	23	5	210	5.62	216
3	50	5	28	5	150	5.62	156
3	50	5	33	5	150	5.62	156
3	50	3	38	5	90	5.62	96
3	50	3	44	6	75	5.62	81
3	50	2	51	7	42.85715	5.62	48
3	50	1	56	5	30	5.62	36
3	50	8	61	5	240	5.62	246
3	50	5	62	1	750	5.62	756

FILENAME : B:D45E-C.J13

LOCATION : 45 EAST

SURFACE DESCRIPTION : CL OF DELTA ROAD

DATE : 1/13/86

TIME :

SNOW TEMPERATURE :

AIR TEMPERATURE :

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	3	0	0	5.62	6
3	50	8	8	5	240	5.62	1154
3	50	16	13	5	480	5.62	777
3	50	12	18	5	360	5.62	366
3	50	9	23	5	270	5.62	276
3	50	8	28	5	240	5.62	246
3	50	6	33	5	180	5.62	186
3	50	4	38	5	120	5.62	126
3	50	3	43	5	90	5.62	96
3	50	2	48	5	60	5.62	66
3	50	6	53	5	180	5.62	186
3	50	30	57	4	1125	5.62	1131

FILENAME : B:D105E-C.J13

LOCATION : 105 EAST

SURFACE DESCRIPTION : CL OF DELTA ROAD 30' LEFT OF ORANGE

DATE : 1/13/86

TIME :

SNOW TEMPERATURE :

AIR TEMPERATURE :

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	1	0	0	5.62	6
3	50	9	6	5	270	5.62	1295
3	50	9	11	5	270	5.62	441
3	50	6	16	5	180	5.62	186
3	50	6	21	5	180	5.62	186
3	50	6	26	5	180	5.62	186
3	50	4	31	5	120	5.62	126
3	50	4	36	5	120	5.62	126
3	50	3	41	5	90	5.62	96
3	50	2	49	8	37.5	5.62	43
3	50	14	62	13	161.5385	5.62	167

FILENAME : B:D195E-C.J13

LOCATION : 195 EAST

SURFACE DESCRIPTION : CL OF DELTA ROAD 25' LEFT OF ORANGE

DATE : 1/13/86

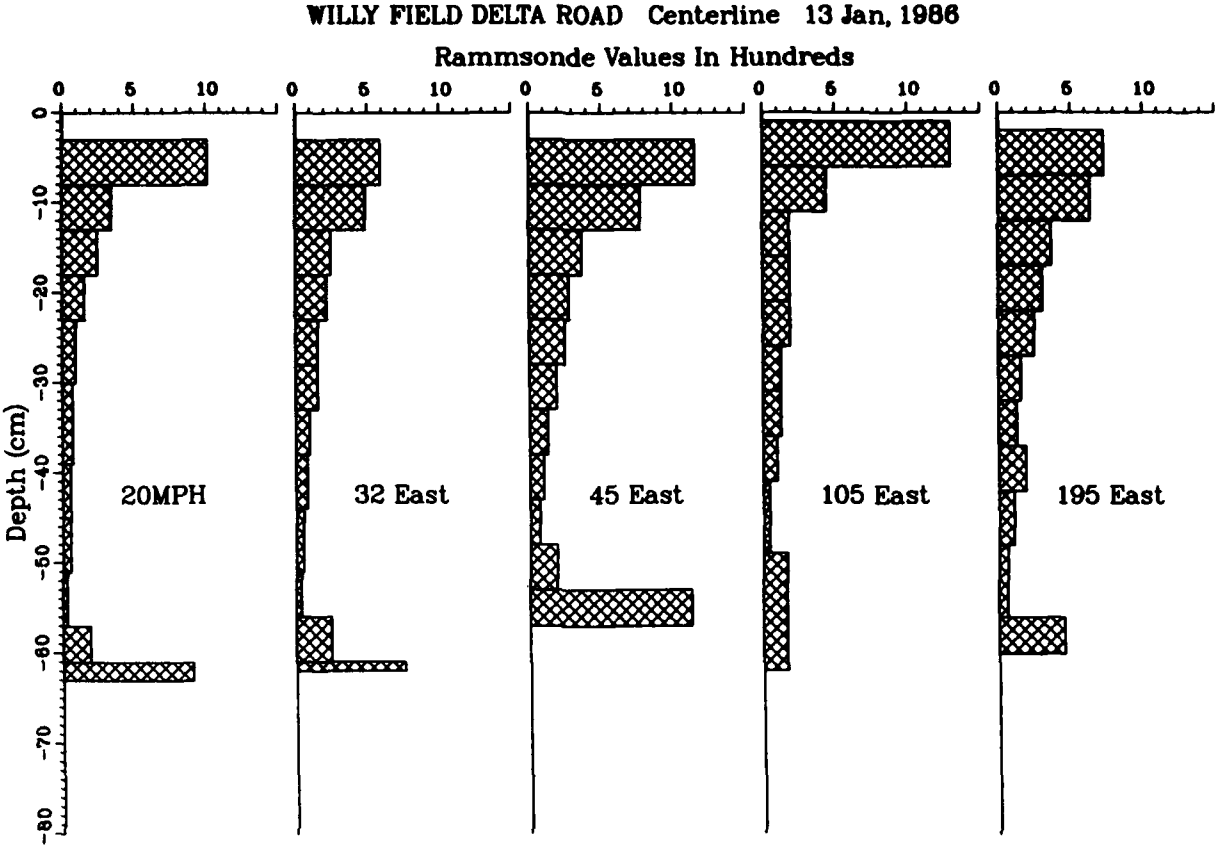
TIME :

SNOW TEMPERATURE :

AIR TEMPERATURE :

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	2	0	0	5.62	6
3	50	5	7	5	150	5.62	731
3	50	13	12	5	390	5.62	633
3	50	12	17	5	360	5.62	366
3	50	10	22	5	300	5.62	306
3	50	8	27	5	240	5.62	246
3	50	5	32	5	150	5.62	156
3	50	4	37	5	120	5.62	126
3	50	6	42	5	180	5.62	186
3	50	4	48	6	100	5.62	106
3	50	3	56	8	56.25	5.62	62
3	50	12	60	4	450	5.62	456


WILLY FIELD DELTA ROAD Centerline 13 Jan, 1986
Rammsonde Values In Hundreds
0
5
10
0
-10
-20
-30
-40
-50
-60
-70
-80
Depth (cm)
20MPH
32 East
45 East
105 East
195 East

RAMMSONDE DATA AND GRAPHIC PROFILES
Approximately 20 and 200 ft to south of Shuttle Road
(Stations: 20 MPH sign, 32 east, 45 east, 105 east, 195 east.)

FILENAME : B:020M-20R.J08
LOCATION : 20 MPH
SURFACE DESCRIPTION : 20' SOUTH OF GREEN (OFF ROAD)
DATE : 1/08/86
TIME : 14:20
SNOW TEMPERATURE :
AIR TEMPERATURE :
CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	4	0	0	5.62	6
3	50	1	13	9	16.66667	5.62	67
3	50	2	18	5	60	5.62	66
3	50	3	23	5	90	5.62	96
3	50	1	28	5	30	5.62	36
3	50	1	33	5	30	5.62	36
3	50	2	38	5	60	5.62	66
3	50	3	48	10	45	5.62	51
3	50	4	53	5	120	5.62	126
3	50	4	58	5	120	5.62	126
3	50	8	60	2	600	5.62	606

FILENAME : B:032E-25R.J06

LOCATION : 32 EAST

SURFACE DESCRIPTION : 25' SOUTH TO GREEN (OFF ROAD)

DATE : 1/08/86

TIME : 15:14

SNOW TEMPERATURE : -5.0

AIR TEMPERATURE : 0.0

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	2	0	0	5.62	6
3	50	1	26	24	6.25	5.62	12
3	50	1	34	8	18.75	5.62	24
3	50	1	43	9	16.66667	5.62	22
3	50	4	48	5	120	5.62	126
3	50	17	53	5	510	5.62	516
3	50	15	58	5	450	5.62	456
3	50	11	63	5	330	5.62	336
3	50	9	68	5	270	5.62	276

FILENAME : B:045E-25R.J08

LOCATION : 45 EAST

SURFACE DESCRIPTION : 25' SOUTH OF GREEN (OFF ROAD)

DATE : 1/08/86

TIME : 16:49

SNOW TEMPERATURE : -5.5

AIR TEMPERATURE : +0.1

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	3	0	0	5.62	6
3	50	1	7	4	37.5	5.62	203
3	50	1	13	6	25	5.62	49
3	50	1	18	5	30	5.62	36
3	50	1	23	5	30	5.62	36
3	50	1	27	4	37.5	5.62	43
3	50	2	40	13	23.07692	5.62	29
3	50	1	43	3	50	5.62	56
3	50	7	48	5	210	5.62	216
3	50	11	53	5	330	5.62	336
3	50	18	58	5	540	5.62	546

FILENAME : B:0105E25R.J09

LOCATION : 105 EAST

SURFACE DESCRIPTION : 25' SOUTH OF GREEN (OFF ROAD)

DATE : 1/09/86

TIME : 16:00

SNOW TEMPERATURE : -4.1

AIR TEMPERATURE : -1.7

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	3	0	0	5.62	6
3	50	1	11	8	18.75	5.62	73
3	50	1	13	2	75	5.62	129
3	50	3	18	5	90	5.62	96
3	50	1	23	5	30	5.62	36
3	50	1	28	5	30	5.62	36
3	50	1	33	5	30	5.62	36
3	50	2	38	5	60	5.62	66
3	50	1	45	7	21.42857	5.62	27
3	50	6	48	3	300	5.62	306
3	50	10	50	2	750	5.62	756

FILENAME : B:0195E25R.J13

LOCATION : 195 EAST

SURFACE DESCRIPTION : 25' SOUTH OF GREEN (OFF ROAD)

DATE : 1/13/86

TIME : 10:57

SNOW TEMPERATURE : -2.1

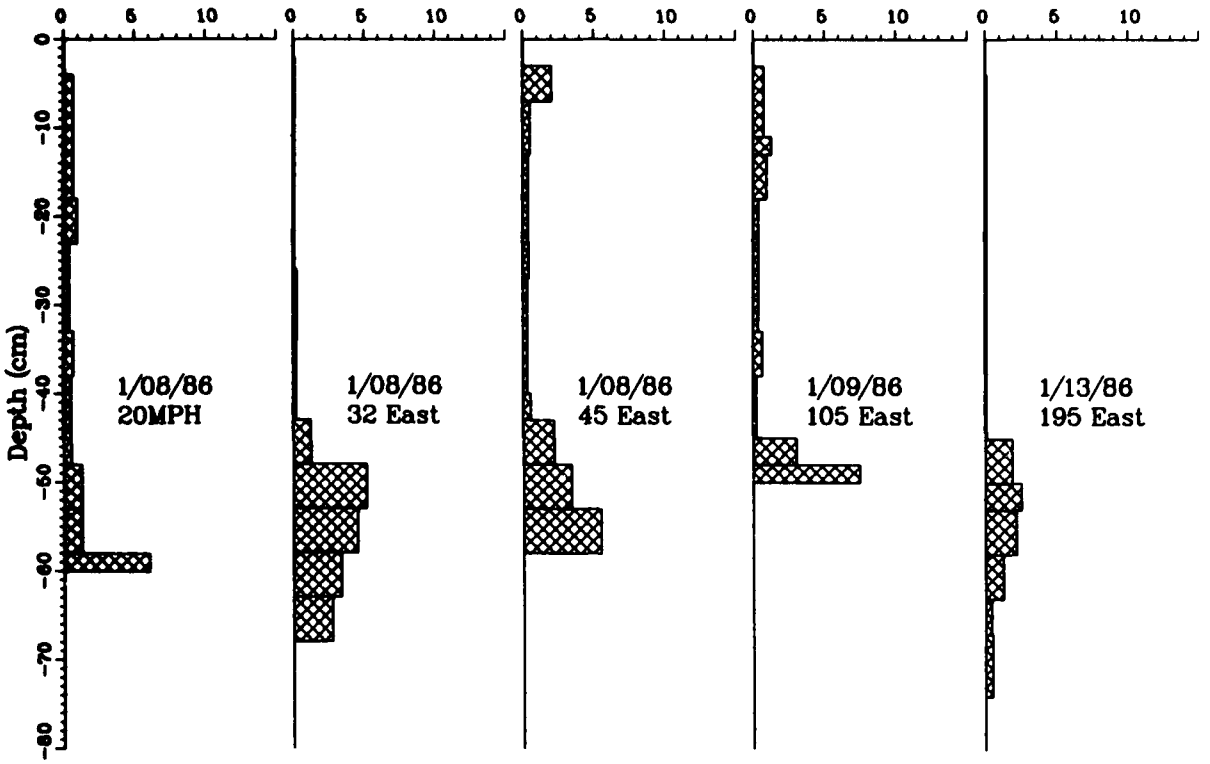
AIR TEMPERATURE : -2.6

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	4	0	0	5.62	6
3	50	1	28	24	6.25	5.62	12
3	50	1	45	17	8.823529	5.62	14
3	50	6	50	5	180	5.62	186
3	50	5	53	3	250	5.62	256
3	50	7	58	5	210	5.62	216
3	50	4	63	5	120	5.62	126
3	50	1	67	4	37.5	5.62	43
3	50	2	74	7	42.85715	5.62	48

MISC. TESTS APPROX. 25FT OFF ROAD Various Dates

Rammsonde Values In Hundreds



FILENAME : B:020M200R.J13

LOCATION : 20 MPH

SURFACE DESCRIPTION : 200' RIGHT (OFF ROAD)

DATE : 1/13/86

TIME :

SNOW TEMPERATURE :

AIR TEMPERATURE :

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	4	0	0	5.62	6
3	50	1	24	20	7.5	5.62	13
3	50	1	31	7	21.42857	5.62	27
3	50	1	44	13	11.53846	5.62	17
3	50	6	51	7	128.5714	5.62	134
3	50	11	56	5	330	5.62	336
3	50	3	61	5	90	5.62	96
3	50	2	66	5	60	5.62	66
3	50	2	71	5	60	5.62	66
3	50	3	76	5	90	5.62	96

FILENAME : B:032E200R.J13

LOCATION : 32 EAST

SURFACE DESCRIPTION : 200' RIGHT (OFF ROAD)

DATE : 1/13/86

TIME :

SNOW TEMPERATURE :

AIR TEMPERATURE :

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	3	0	0	5.62	6
3	50	1	29	26	5.769231	5.62	11
3	50	2	33	4	75	5.62	81
3	50	4	38	5	120	5.62	126
3	50	4	44	6	100	5.62	106
3	50	2	51	7	42.85715	5.62	48
3	50	3	56	5	90	5.62	96
3	50	4	61	5	120	5.62	126
3	50	2	66	5	60	5.62	66
3	50	3	71	5	90	5.62	96
3	50	2	76	5	60	5.62	66

FILENAME : B:045E-200.J13

LOCATION : 45 EAST

SURFACE DESCRIPTION : 200' RIGHT (OFF ROAD)

DATE : 1/13/86

TIME :

SNOW TEMPERATURE :

AIR TEMPERATURE :

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	7	0	0	5.62	6
3	50	3	22	15	30	5.62	36
3	50	1	32	10	15	5.62	21
3	50	3	38	6	75	5.62	81
3	50	5	43	5	150	5.62	156
3	50	2	48	5	60	5.62	66
3	50	3	53	5	90	5.62	96
3	50	2	58	5	60	5.62	66
3	50	3	63	5	90	5.62	96
3	50	4	68	5	120	5.62	126
3	50	2	73	5	60	5.62	66

FILENAME : B:0105E200.J13

LOCATION : 105 EAST

SURFACE DESCRIPTION : 200' RIGHT (OFF ROAD)

DATE : 1/13/86

TIME :

SNOW TEMPERATURE :

AIR TEMPERATURE :

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	3	0	0	5.62	6
3	50	1	40	37	4.054054	5.62	10
3	50	1	52	12	12.5	5.62	18
3	50	1	58	6	25	5.62	31
3	50	1	63	5	30	5.62	36
3	50	1	69	6	25	5.62	31
3	50	1	76	7	21.42857	5.62	27

FILENAME : B:0195E230.J13

LOCATION : 195 EAST

SURFACE DESCRIPTION : 230' RIGHT (OFF ROAD)

DATE : 1/13/86

TIME :

SNOW TEMPERATURE :

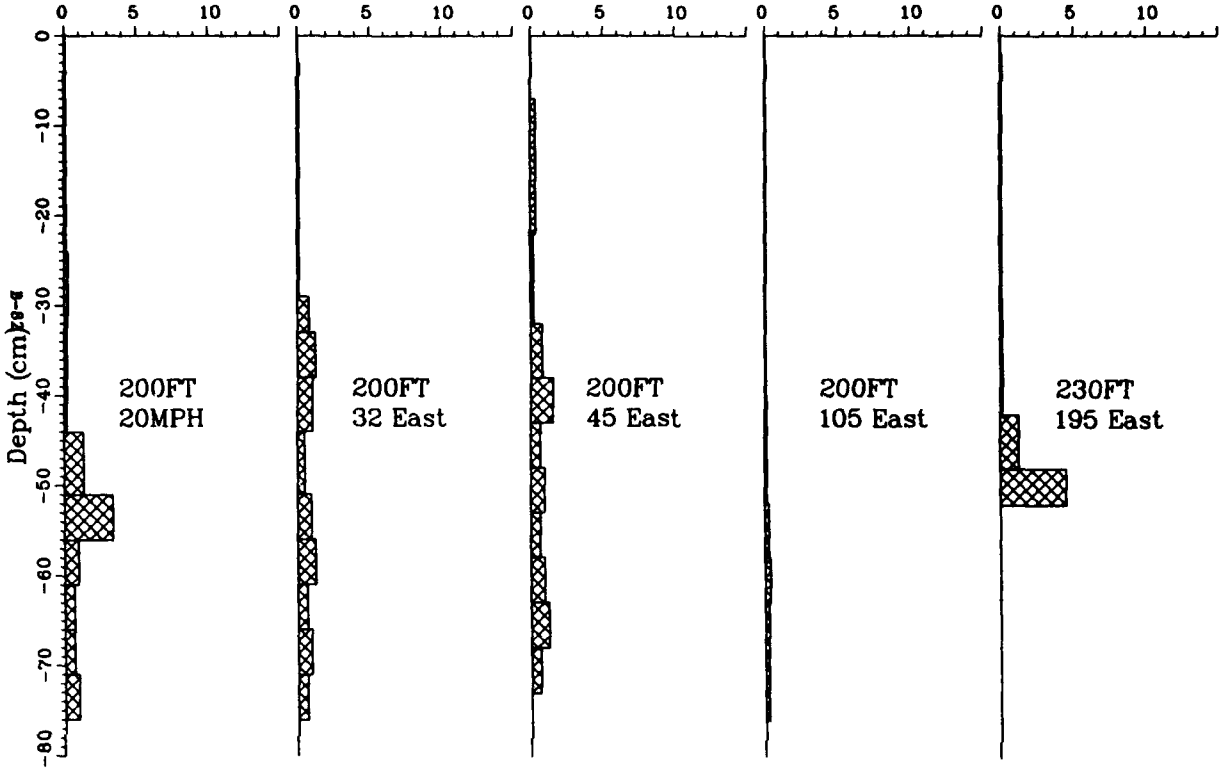
AIR TEMPERATURE :

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	2	0	0	5.62	6
3	50	1	29	27	5.555556	5.62	11
3	50	1	42	13	11.53846	5.62	17
3	50	5	48	6	125	5.62	131
3	50	12	52	4	450	5.62	456

MISC. TESTS APPROX. 200FT OFF ROAD 13 Jan, 1986

Rammsonde Values In Hundreds



RAMMSONDE DATA AND GRAPHIC PROFILES

Near transition zone, Shuttle Road, on tractor-compacted snow, Main Street, Williams Field Camp, adjacent to snow pits, Williams Field Skiway, McMurdo Shuttle Road, 30°cone

FILENAME : B:STRAN20R.J07

LOCATION : TRANSITION + 250 YARDS

SURFACE DESCRIPTION : 20' RIGHT

DATE : 1/07/86

TIME :

SNOW TEMPERATURE :

AIR TEMPERATURE :

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	3	0	0	5.62	6
3	50	2	8	5	60	5.62	306
3	50	7	13	5	210	5.62	345
3	50	16	18	5	480	5.62	486
3	50	28	23	5	840	5.62	846
3	50	36	28	5	1080	5.62	1086
3	50	20	33	5	600	5.62	606
3	50	14	38	5	420	5.62	426
3	50	10	43	5	300	5.62	306
3	50	8	48	5	240	5.62	246
3	50	5	53	5	150	5.62	156
3	50	5	58	5	150	5.62	156

FILENAME : B:STRAN28R.J07

LOCATION : TRANSITION + 250 YARDS

SURFACE DESCRIPTION : 28' RIGHT

DATE : 1/07/86

TIME : 14:14

SNOW TEMPERATURE : -0.3

AIR TEMPERATURE : +2.0

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	3	0	0	5.62	6
3	50	3	8	5	90	5.62	449
3	50	12	13	5	360	5.62	585
3	50	6	18	5	180	5.62	186
3	50	3	23	5	90	5.62	96
3	50	4	28	5	120	5.62	126
3	50	3	33	5	90	5.62	96
3	50	3	38	5	90	5.62	96
3	50	3	43	5	90	5.62	96
3	50	2	48	5	60	5.62	66
3	50	2	53	5	60	5.62	66
3	50	3	58	5	90	5.62	96
3	50	2.5	63	5	75	5.62	81

FILENAME : B:STRAN50R.J07

LOCATION : TRANSITION

SURFACE DESCRIPTION : 50' RIGHT

DATE : 1/07/86

TIME :

SNOW TEMPERATURE : -1.4

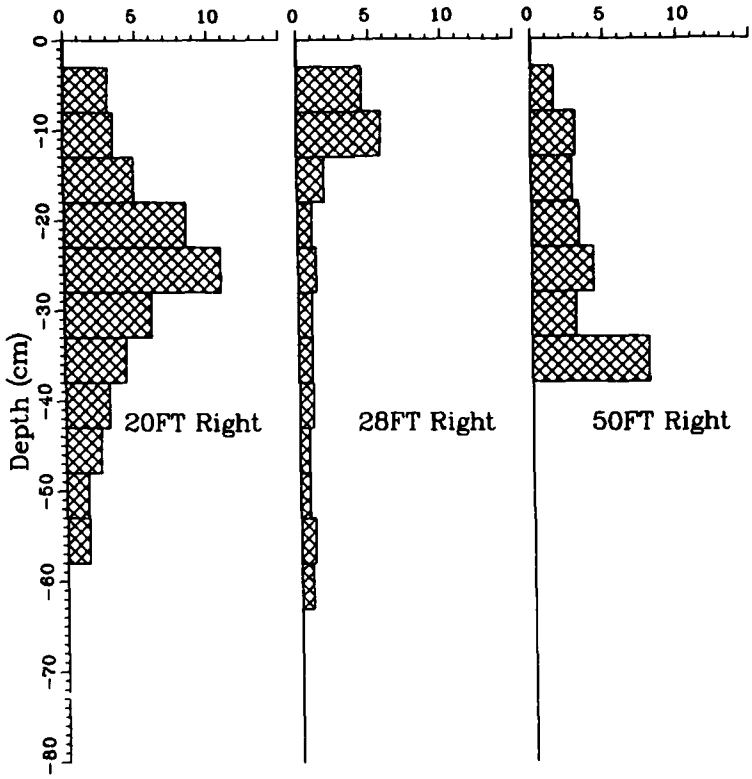
AIR TEMPERATURE : +3.0

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
1	50	0	3	0	0	3.62	4
1	50	3	8	5	30	3.62	158
1	50	19	13	5	190	3.62	310
1	50	28	18	5	280	3.62	284
1	50	32	23	5	320	3.62	324
1	50	42	28	5	420	3.62	424
1	50	30	33	5	300	3.62	304
1	50	80	38	5	800	3.62	804

WILLY FIELD ROAD Transition Zone 7 Jan, 1986

Rammsonde Values In Hundreds



FILENAME : B:W5-14-30.J10

LOCATION : WILLY FIELD

SURFACE DESCRIPTION : 30.2' FROM BUILDING 5 TOWARD 14

DATE : 1/10/86

TIME :

SNOW TEMPERATURE : -1.6

AIR TEMPERATURE : 0.0

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	1	0	0	5.62	6
3	50	4	6	5	120	5.62	590
3	50	10	11	5	300	5.62	489
3	50	16	16	5	480	5.62	486
3	50	26	21	5	780	5.62	786
3	50	35	24	3	1750	5.62	1756

FILENAME : B:WS-14-68.J10

LOCATION : WILLY FIELD

SURFACE DESCRIPTION : 68' FROM BUILDING 5 TOWARD 14

DATE : 1/10/86

TIME : 11:50

SNOW TEMPERATURE : -0.2

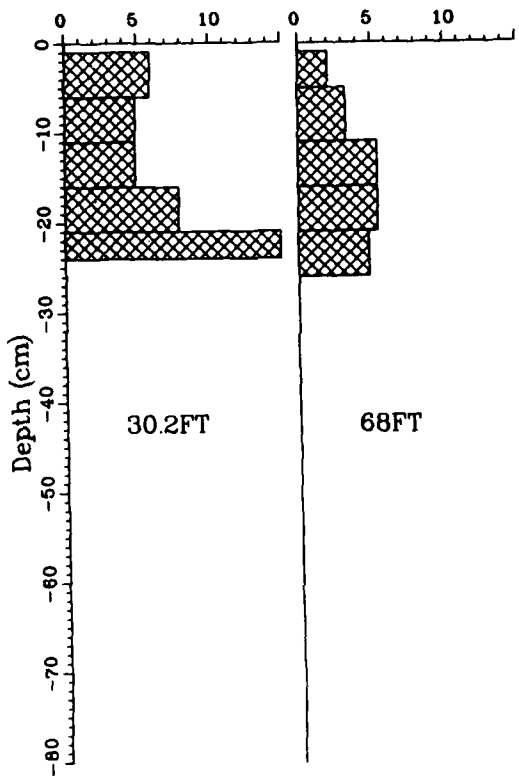
AIR TEMPERATURE : -0.6

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	1	0	0	5.62	6
3	50	1	5	4	37.5	5.62	203
3	50	8	11	6	200	5.62	329
3	50	18	16	5	540	5.62	546
3	50	18	21	5	540	5.62	546
3	50	16	26	5	480	5.62	486

WILLY FIELD BUILDINGS From 5 Towards 14 10, Jan, 1986

Rammsonde Values In Hundreds



FILENAME : B:W5SNOPIT.J11

LOCATION : WILLY FIELD

SURFACE DESCRIPTION : SNOWPIT

DATE : 1/11/86

TIME :

SNOW TEMPERATURE :

AIR TEMPERATURE :

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	3	0	0	5.62	6
3	50	2	8	5	60	5.62	308
3	50	2	13	5	60	5.62	105
3	50	2	18	5	60	5.62	66
3	50	1	36	18	8.333333	5.62	14
3	50	1	40	4	37.5	5.62	43
3	50	2	50	10	30	5.62	36
3	50	2	60	10	30	5.62	36
3	50	2	63	3	100	5.62	106
3	50	4	68	5	120	5.62	126
3	50	3	73	5	90	5.62	96

FILENAME : B:W7-3PIT.J11

LOCATION : WILLY FIELD

SURFACE DESCRIPTION : 7/3 SNOWPIT

DATE : 1/11/86

TIME : 13:37

SNOW TEMPERATURE :

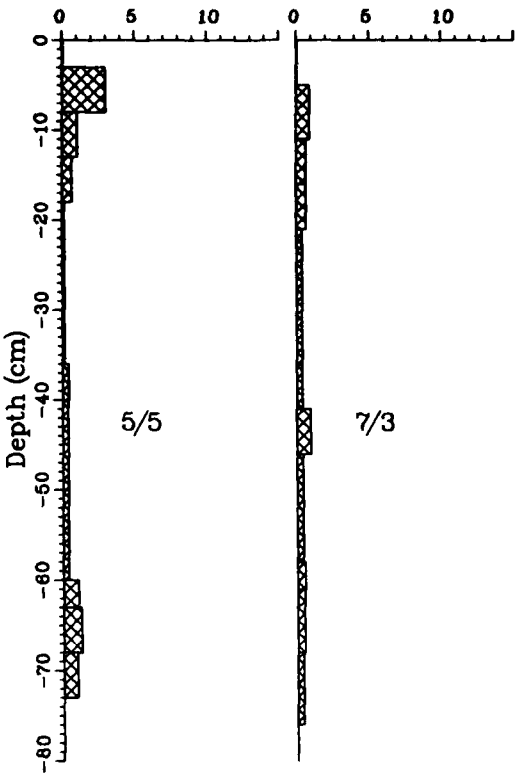
AIR TEMPERATURE :

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
3	50	0	5	0	0	5.62	6
3	50	1	11	6	25	5.62	92
3	50	2	16	5	60	5.62	66
3	50	2	21	5	60	5.62	66
3	50	2	31	10	30	5.62	36
3	50	1	36	5	30	5.62	36
3	50	1	41	5	30	5.62	36
3	50	3	46	5	90	5.62	96
3	50	3	58	12	37.5	5.62	43
3	50	1	61	3	50	5.62	56
3	50	2	68	7	42.85715	5.62	48
3	50	2	76	8	37.5	5.62	43

RAMMSONDES NEAR PIT 11 Jan, 1986

Rammsonde Values In Hundreds



FILENAME : B:MBR1A.J06

LOCATION : McMurdo Snow Road .1A

SURFACE DESCRIPTION :

DATE : 1/6/86

TIME : 13:45

SNOW TEMPERATURE : -1

AIR TEMPERATURE : +6

CONE TYPE : 30

W	H	N	D	X	W*H*N/X	W+Q	R
1	30	0	3	0	0	2	4
1	30	3	10	7	12.85714	2	42
1	30	4	15	5	24	2	52
1	30	6	20	5	36	2	76
1	30	6	25	5	36	2	76
1	30	6	30	5	36	2	76
1	30	12	35	5	72	2	148
1	30	15	40	5	90	2	184
1	30	22	45	5	132	2	268
1	30	22	50	5	132	2	268
1	30	20	55	5	120	2	244
1	30	23	60	5	138	2	280

FILENAME : B:MSR1B.J06

LOCATION : McMurdo Snow Road .1B

SURFACE DESCRIPTION :

DATE : 1/6/86

TIME : 16:15

SNOW TEMPERATURE :

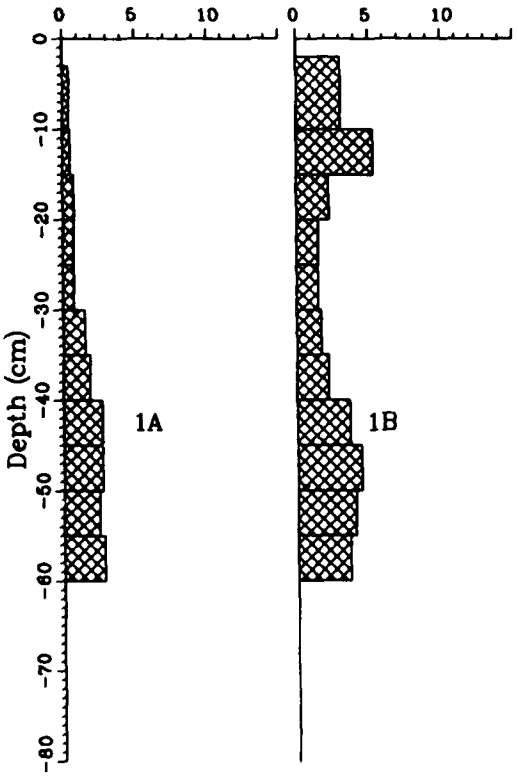
AIR TEMPERATURE :

CONE TYPE : 30

W	H	N	D	X	W*H*N/X	W+Q	R
1	30	0	2	0	0	2	4
1	30	29	10	8	108.75	2	310
1	30	44	15	5	264	2	532
3	30	6	20	5	108	4	224
3	30	4	25	5	72	4	152
3	30	4	30	5	72	4	152
1	30	14	35	5	84	2	172
1	30	18	40	5	108	2	220
3	30	10	45	5	180	4	368
3	30	12	50	5	216	4	440
3	30	11	55	5	198	4	404
3	30	10	60	5	180	4	368

McMurdo Snow Road 6 Jan, 1986

Rammsonde Values In Hundreds



TESTS WITH CLEGG IMPACT DEVICE AT MCMURDO

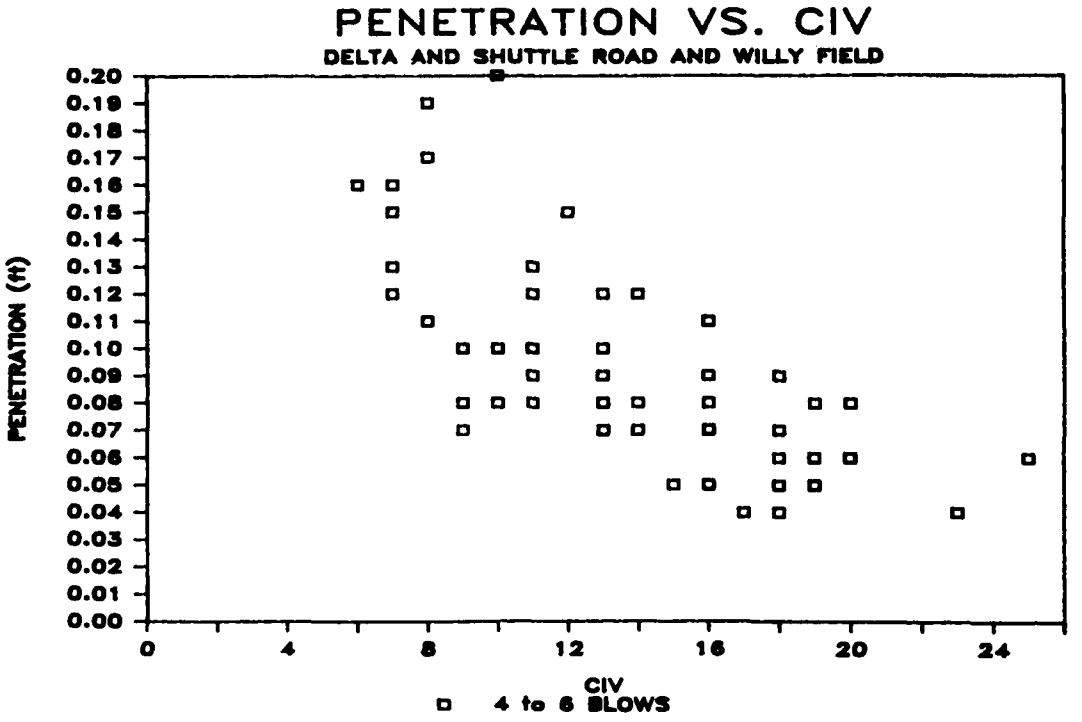
Clegg impact tests were made on the Shuttle Road, on the Delta Road, and on the Williams Field aircraft skiway. Since these were taken within a few feet of the corresponding Rammsonde tests, the notation for location is essentially the same as for the Rammsonde tests. The Clegg tests were not, however, taken at all locations where Ramm tests were taken, as the snow strength in some off-road locations was so low that the Clegg test would have been of doubtful significance.

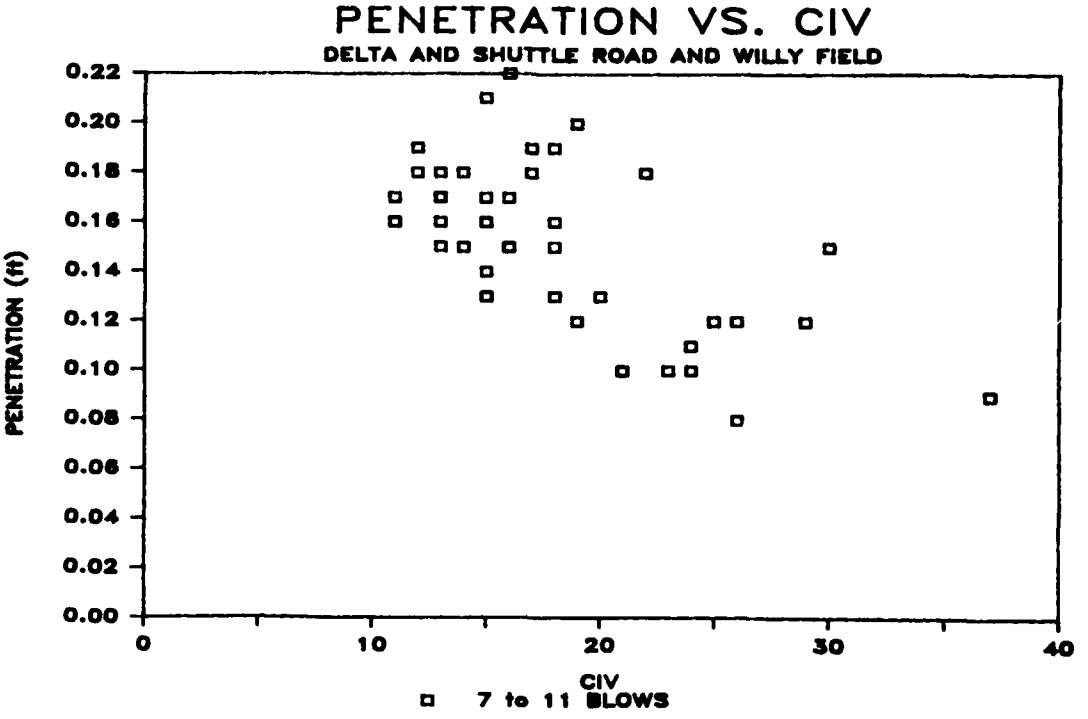
The conventional Clegg test, as run on soil subgrades or select base course material, consists of recording the CIV at the end of four blows of the drop hammer. This "standard" was used for the snow road and runway at McMurdo, and formed the basis for the CIVs cited in the main body of the report.

In addition to these "standard" Clegg tests, a modified version was made at some locations with a view toward determining the characteristics of the Clegg test, especially on snow. The modified test consisted of recording the CIV after each hammer drop, and continuing until eight (and occasionally more) drops were made. In these cases, it would be possible to report either the CIV(4) value or the CIV(8) value. That is, the CIV(4) value from a modified test could be compared to or averaged with the "standard"CIVs, yet the CIV(8) value could be compared with the CIV(8) values from other modified tests.

In a further effort toward understanding the Clegg test as it applies to snow, the accumulated penetration of the drop hammer (after the final blow) was measured and recorded. It became apparent in the field that, in general, large penetrations occurred with relatively low CIVs, and vice versa. The results of this comparison are shown on the following graphs. They are grouped as "4 to 6 blows" and "7 to 11 blows." The first group consists mostly of tests ending at the fourth blow, while the second group consists mostly of tests ending at the eighth blow. The others include tests in which the tee-handle on the Clegg device hung up on the guide tube before the eighth blow was reached, or where the test did not end at either four or eight blows for some other reason.

It can be seen from these plots that the accumulated penetration does decrease as the CIV increases, as would appear reasonable. The degree to which these factors can be correlated needs further analysis.


PENETRATION VS. CIV
DELTA AND SHUTTLE ROAD AND WILLY FIELD
PENETRATION (ft)
0.20
0.19
0.18
0.17
0.16
0.15
0.14
0.13
0.12
0.11
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
0
4
8
12
16
20
24
CIV
4 to 6 BLOWS


PENETRATION VS. CIV
DELTA AND SHUTTLE ROAD AND WILLY FIELD
PENETRATION (ft)
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
0
10
20
30
40
CIV
7 to 11 BLOWS

RAMMSONDE HARDNESS AT SOUTH POLE STATION

Ramm profiles were taken on the skiway at South Pole Station at markers 3000 and 6000 ft, as well as at some other locations. These have been depicted on the sketch map of Figure 1 in the body of the text. Ramm profiles were taken at 50-ft intervals from one edge of the runway to the other. As the width was 300 ft, the 150-ft position corresponds to the centerline.

Nearly all of the Ramm data from South Pole Station were taken using a cone with a 30° included angle rather than the 60° cone used at McMurdo. This choice was due to the harder snow encountered at the South Pole. A few side-by-side comparisons were made at both cones in an attempt to establish a correlation between the two cone angles. However, because of the very few data points, this correlation was not considered statistically reliable, and the previously established relationship (from data by Niedringhaus 1965) was used:

$$R(30° \text{ cone}) \times 2 = \text{equivalent } R \text{ (60° cone)}.$$

Note: Since the preparation of this report, reanalysis of Niedringhaus's data has been done, which resulted in a correction factor of approximately 1.5, instead of 2. Therefore, the Ramm values obtained with the 30° cone (for depths greater than 10 cm), shown in the following tables and graphs, should be multiplied by 0.75 to obtain the correct Ramm hardness values.

FILENAME : B:SPSW3000.J09

LOCATION : SOUTH POLE SKIWAY 3000' AT EDGE

SURFACE DESCRIPTION :

DATE : 1/9/86

TIME : 9:00

SNOW TEMPERATURE :

AIR TEMPERATURE :

CONE TYPE : 30

W	H	N	D	X	W*H*N/X	W*Q	R
3	40	0	12	0	0	4	8
3	40	1	15	3	40	4	176
3	40	2	16	1	240	4	976
3	40	2	20	4	60	4	102
3	40	4	25	5	96	4	200
3	40	2	30	5	48	4	104
3	40	2	35	5	48	4	104
3	40	3	40	5	72	4	152
3	40	9	45	5	216	4	440
3	40	9	50	5	216	4	440
3	40	5	55	5	120	4	248
3	40	5	60	5	120	4	248
3	40	5	65	5	120	4	248
3	40	8	70	5	192	4	392
3	40	12	75	5	288	4	584
3	40	8	80	5	192	4	392

RAMMSONDE HARDNESS AT SOUTH POLE STATION
South Pole Skiway at 3000-ft marker

FILENAME : B:SPSW503.J09

LOCATION : SOUTH POLE SKIWAY 3000' 50' FROM EDGE

SURFACE DESCRIPTION :

DATE : 1/9/86

TIME : 9:20

SNOW TEMPERATURE :

AIR TEMPERATURE :

CONE TYPE : 30

W	H	N	D	X	W*H*N/X	W+Q	R
3	40	0	7	0	0	4	8
3	40	1	21	14	8.571428	4	25
3	40	2	25	4	60	4	128
3	40	7	30	5	168	4	344
3	40	6	35	5	144	4	296
3	40	3	40	5	72	4	152
3	40	2	45	5	48	4	104
3	40	1	50	5	24	4	56
3	40	2	55	5	48	4	104
3	40	2	60	5	48	4	104
3	40	6	65	5	144	4	296
3	40	5	70	5	120	4	248
3	40	2	75	5	48	4	104
3	40	3	80	5	72	4	152

FILENAME : B:SPSW1003.J09

LOCATION : SOUTH POLE SKIWAY 3000' 100' FROM EDGE

SURFACE DESCRIPTION :

DATE : 1/9/86

TIME : 9:45

SNOW TEMPERATURE :

AIR TEMPERATURE :

CONE TYPE : 30

W	H	N	D	X	W*H*N/X	W+Q	R
3	40	0	5	0	0	4	8
3	40	1	11	6	20	4	67
3	40	1	15	4	30	4	54
3	40	2	20	5	48	4	104
3	40	3	25	5	72	4	152
3	40	2	30	5	48	4	104
3	40	1	35	5	24	4	56
3	40	1	40	5	24	4	56
3	40	2	47	7	34.28571	4	77
3	40	1	50	3	40	4	88
3	40	5	55	5	120	4	248
3	40	8	60	5	192	4	392
3	40	5	65	5	120	4	248
3	40	6	70	5	144	4	296
3	40	7	75	5	168	4	344
3	40	6	80	5	144	4	296

FILENAME : B:SPSW1503.J09

LOCATION : SOUTH POLE SKIWAY 3000' 150' FROM EDGE

SURFACE DESCRIPTION :

DATE : 1/9/86

TIME : 9:53

SNOW TEMPERATURE :

AIR TEMPERATURE :

CONE TYPE : 30

W	H	N	D	X	W*H*N/X	W+Q	R
3	40	0	6	0	0	4	8
3	40	1	10	4	30	4	136
3	40	5	15	5	120	4	198
3	40	4	20	5	96	4	200
3	40	3	25	5	72	4	152
3	40	3	30	5	72	4	152
3	40	3	36	6	60	4	128
3	40	2	43	7	34.28571	4	77
3	40	1	45	2	60	4	128
3	40	4	50	5	96	4	200
3	40	7	55	5	168	4	344
3	40	8	60	5	192	4	392
3	40	15	65	5	360	4	728
3	40	22	70	5	528	4	1064
3	40	11	75	5	264	4	536
3	40	7	80	5	168	4	344

FILENAME : B:SPSW2003.J09

LOCATION : SOUTH POLE SKIWAY 3000' 200' FROM EDGE

SURFACE DESCRIPTION :

DATE : 1/9/86

TIME : 11:15

SNOW TEMPERATURE :

AIR TEMPERATURE :

CONE TYPE : 30

W	H	N	D	X	W*H*N/X	W+Q	R
3	40	0	4	0	0	4	8
3	40	1	24	20	6	4	20
3	40	1	36	12	10	4	28
3	40	3	40	4	90	4	188
3	40	6	45	5	144	4	296
3	40	3	51	6	60	4	128
3	40	3	56	5	72	4	152
3	40	5	60	4	150	4	308
3	40	5	65	5	120	4	248
3	40	3	71	6	60	4	128
3	40	2	75	4	60	4	128
3	40	3	80	5	72	4	152

FILENAME : B:SPSW2503.J09

LOCATION : SOUTH POLE SKIWAY 3000' 250' FROM EDGE

SURFACE DESCRIPTION :

DATE : 1/9/86

TIME : 11:20

SNOW TEMPERATURE :

AIR TEMPERATURE :

CONE TYPE : 30

W	H	N	D	X	W*H*N/X	W+Q	R
3	40	0	11	0	0	4	8
3	40	1	15	4	30	4	136
3	40	2	20	5	48	4	83
3	40	2	26	6	40	4	88
3	40	3	31	5	72	4	152
3	40	5	35	4	150	4	308
3	40	5	40	5	120	4	248
3	40	3	45	5	72	4	152
3	40	4	51	6	80	4	168
3	40	3	55	4	90	4	188
3	40	2	60	5	48	4	104
3	40	2	66	6	40	4	88
3	40	3	71	5	72	4	152
3	40	2	75	4	60	4	128
3	40	2	80	5	48	4	104

FILENAME : B:SPSW3003.J09

LOCATION : SOUTH POLE SKIWAY 3000' OPP. EDGE (300')

SURFACE DESCRIPTION :

DATE : 1/9/86

TIME : 11:30

SNOW TEMPERATURE :

AIR TEMPERATURE :

CONE TYPE : 30

W	H	N	D	X	W*H*N/X	W+Q	R
3	40	0	7	0	0	4	8
3	40	1	14	7	17.14286	4	59
3	40	2	19	5	48	4	104
3	40	3	26	7	51.42857	4	111
3	40	2	33	7	34.28571	4	77
3	40	2	46	13	18.46154	4	45
3	40	2	51	5	48	4	104
3	40	3	56	5	72	4	152
3	40	2	64	8	30	4	68
3	40	1	72	8	15	4	38
3	40	1	81	9	13.33333	4	35

FILENAME : B:SPSWPIT3.J09

LOCATION : SOUTH POLE SKIWAY 3000' SNOWPIT

SURFACE DESCRIPTION :

DATE : 1/9/86

TIME : 11:33

SNOW TEMPERATURE :

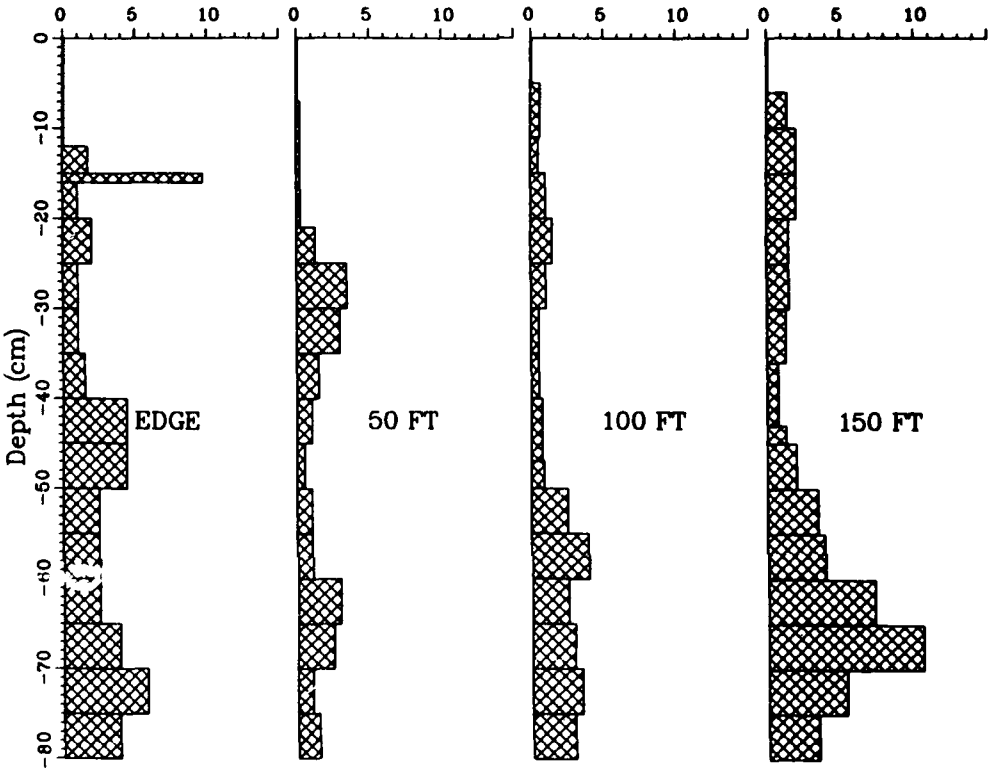
AIR TEMPERATURE :

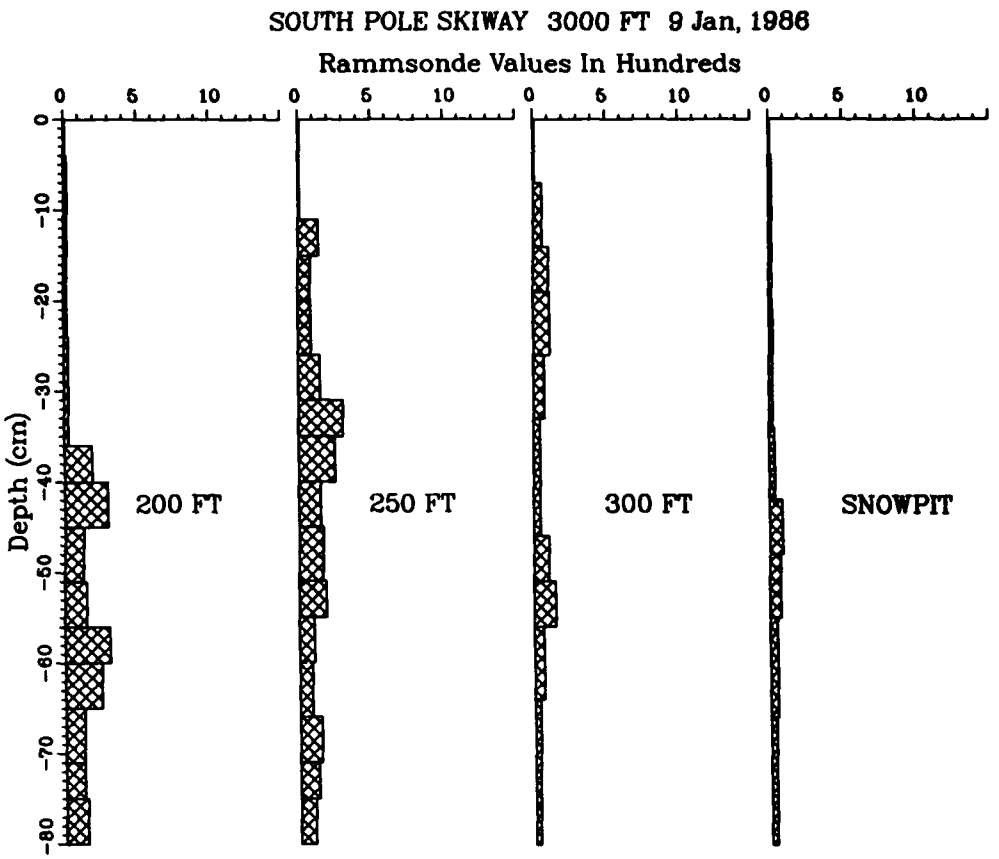
CONE TYPE : 30

W	H	N	D	X	W*H*N/X	W+Q	R
3	40	0	4	0	0	4	8
3	40	1	21	17	7.058824	4	22
3	40	1	34	13	9.230769	4	26
3	40	1	42	8	15	4	38
3	40	2	48	6	40	4	88
3	40	2	55	7	34.28571	4	77
3	40	2	66	11	21.81818	4	52
3	40	1	74	8	15	4	38
3	40	1	82	8	15	4	38

SOUTH POLE SKIWAY 3000 FT 9 Jan, 1986

Rammsonde Values In Hundreds




SOUTH POLE SKIWAY 3000 FT 9 Jan, 1986
Rammsonde Values In Hundreds
0
5
10
Depth (cm)
0
-10
-20
-30
-40
-50
-60
-70
-80
200 FT
250 FT
300 FT
SNOWPIT

RAMMSONDE HARDNESS AT SOUTH POLE STATION

South Pole Skiway at 6000-ft marker

FILENAME : B:SPSW6000.J09

LOCATION : SOUTH POLE SKIWAY 6000' AT EDGE

SURFACE DESCRIPTION :

DATE : 1/9/86

TIME : 13:50

SNOW TEMPERATURE :

AIR TEMPERATURE :

CONE TYPE : 30

W	H	N	D	X	W*H*N/X	W+Q	R
3	40	0	13	0	0	4	8
3	40	2	20	7	34.28571	4	107
3	40	2	25	5	48	4	104
3	40	3	35	10	36	4	80
3	40	3	41	6	60	4	128
3	40	2	44	3	80	4	168
3	40	2	50	6	40	4	88
3	40	2	55	5	48	4	104
3	40	3	60	5	72	4	152
3	40	7	65	5	168	4	344
3	40	7	71	6	140	4	288
3	40	3	76	5	72	4	152
3	40	4	80	4	120	4	248

FILENAME : B:SPSW306.J09

LOCATION : SOUTH POLE SKIWAY 6000' 50' FROM EDGE

SURFACE DESCRIPTION :

DATE : 1/9/86

TIME : 13:55

SNOW TEMPERATURE :

AIR TEMPERATURE :

CONE TYPE : 30

W	H	N	D	X	W*H*N/X	W+Q	R
3	40	0	4	0	0	4	8
3	40	1	24	20	6	4	20
3	40	1	31	7	17.14286	4	42
3	40	1	36	5	24	4	56
3	40	2	43	7	34.28571	4	77
3	40	1	50	7	17.14286	4	42
3	40	2	62	12	20	4	48
3	40	2	70	8	30	4	68
3	40	3	80	10	36	4	80

FILENAME : B:SPSW1006.J09

LOCATION : SOUTH POLE SKIWAY 6000' 100' FROM EDGE

SURFACE DESCRIPTION :

DATE : 1/9/86

TIME : 14:00

SNOW TEMPERATURE :

AIR TEMPERATURE :

CONE TYPE : 30

W	H	N	D	X	W*H*N/X	W+Q	R
3	40	0	10	0	0	4	8
3	40	1	24	14	8.571428	4	25
3	40	1	29	5	24	4	56
3	40	3	35	6	60	4	128
3	40	7	40	5	168	4	344
3	40	9	45	5	216	4	440
3	40	6	50	5	144	4	296
3	40	5	55	5	120	4	248
3	40	6	60	5	144	4	296
3	40	10	65	5	240	4	488
3	40	7	70	5	168	4	344
3	40	6	75	5	144	4	296
3	40	3	80	5	72	4	152

FILENAME : B:SPSW1506.J09

LOCATION : SOUTH POLE SKIWAY 6000' 150' FROM EDGE

SURFACE DESCRIPTION :

DATE : 1/9/86

TIME : 14:15

SNOW TEMPERATURE :

AIR TEMPERATURE :

CONE TYPE : 30

W	H	N	D	X	W*H*N/X	W+Q	R
3	40	0	2	0	0	4	8
3	40	7	10	8	105	4	305
3	40	11	15	5	264	4	536
3	40	11	20	5	264	4	536
3	40	7	26	6	140	4	288
3	40	4	30	4	120	4	248
3	40	3	35	5	72	4	152
3	40	3	40	5	72	4	152
3	40	10	45	5	240	4	488
3	40	27	50	5	648	4	1304
3	40	20	55	5	480	4	968
3	40	11	60	5	264	4	536
3	40	9	65	5	216	4	440
3	40	9	70	5	216	4	440
3	40	32	75	5	768	4	1544
3	40	31	80	5	744	4	1496

FILENAME : B:SPSW2006.J09

LOCATION : SOUTH POLE SKIWAY 6000' 200' FROM EDGE

SURFACE DESCRIPTION :

DATE : 1/9/86

TIME : 14:30

SNOW TEMPERATURE :

AIR TEMPERATURE :

CONE TYPE : 30

W	H	N	D	X	W*H*N/X	W+Q	R
3	40	0	4	0	0	4	8
3	40	1	16	12	10	4	28
3	40	1	25	9	13.33333	4	35
3	40	1	29	4	30	4	68
3	40	2	35	6	40	4	88
3	40	2	41	6	40	4	88
3	40	5	45	4	150	4	308
3	40	7	50	5	168	4	344
3	40	5	56	6	100	4	208
3	40	4	61	5	96	4	200
3	40	5	65	4	150	4	308
3	40	13	70	5	312	4	632
3	40	10	75	5	240	4	488
3	40	10	80	5	240	4	488

FILENAME : B:SPSW2506.J09

LOCATION : SOUTH POLE SKIWAY 6000' 250' FROM EDGE

SURFACE DESCRIPTION :

DATE : 1/9/86

TIME : 14:45

SNOW TEMPERATURE :

AIR TEMPERATURE :

CONE TYPE : 30

W	H	N	D	X	W*H*N/X	W+Q	R
3	40	0	6	0	0	4	8
3	40	1	15	9	13.33333	4	49
3	40	1	21	6	20	4	48
3	40	1	31	10	12	4	32
3	40	1	40	9	13.33333	4	35
3	40	2	46	6	40	4	88
3	40	2	50	4	60	4	128
3	40	3	56	6	60	4	128
3	40	2	61	5	48	4	104
3	40	3	66	5	72	4	152
3	40	1	70	4	30	4	68
3	40	1	78	8	15	4	38
3	40	1	82	4	30	4	68

FILENAME : B:SPSWOPP6.J09

LOCATION : SOUTH POLE SKIWAY 6000' OPP. EDGE

SURFACE DESCRIPTION :

DATE : 1/9/86

TIME : 14:50

SNOW TEMPERATURE :

AIR TEMPERATURE :

CONE TYPE : 30

W	H	N	D	X	W*H*N/X	W+Q	R
3	40	0	8	0	0	4	8
3	40	3	15	7	51.42857	4	155
3	40	5	20	5	120	4	248
3	40	5	26	6	100	4	208
3	40	3	30	4	90	4	188
3	40	5	35	5	120	4	248
3	40	6	40	5	144	4	296
3	40	7	45	5	168	4	344
3	40	7	50	5	168	4	344
3	40	5	55	5	120	4	248
3	40	4	60	5	96	4	200
3	40	13	65	5	312	4	632
3	40	9	70	5	216	4	440
3	40	4	76	6	80	4	168
3	40	7	80	4	210	4	428

FILENAME : B:SPSWPIT6.J09

LOCATION : SOUTH POLE SKIWAY 6000' SNOWPIT

SURFACE DESCRIPTION :

DATE : 1/9/86

TIME : 13:30

SNOW TEMPERATURE :

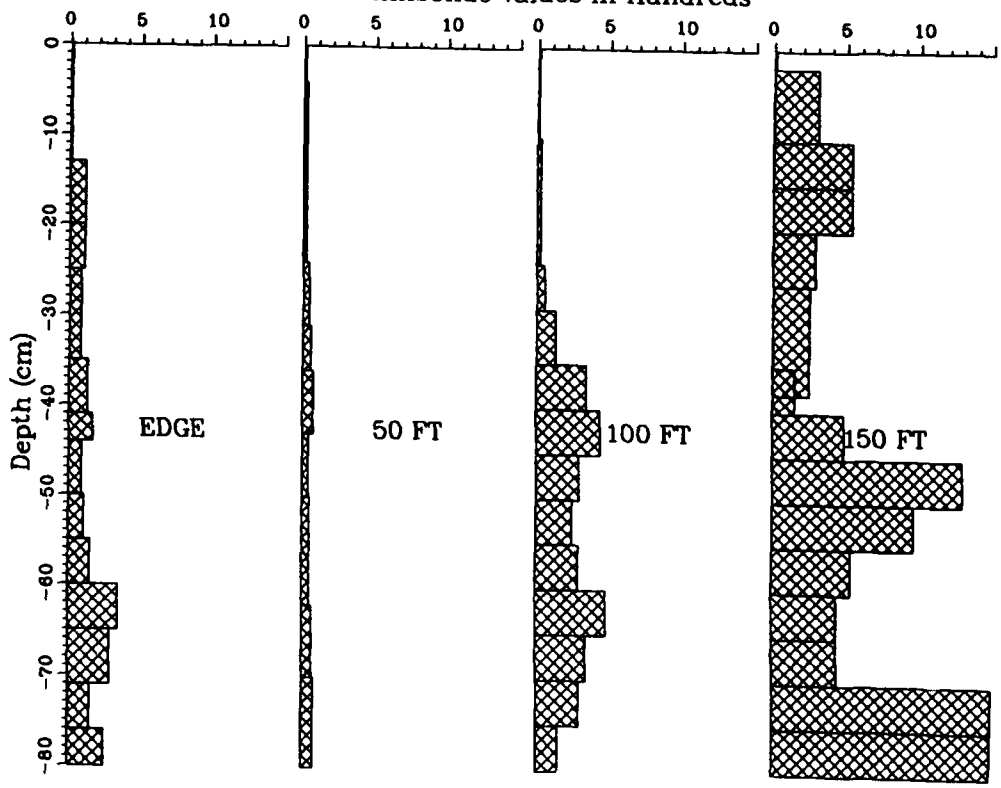
AIR TEMPERATURE :

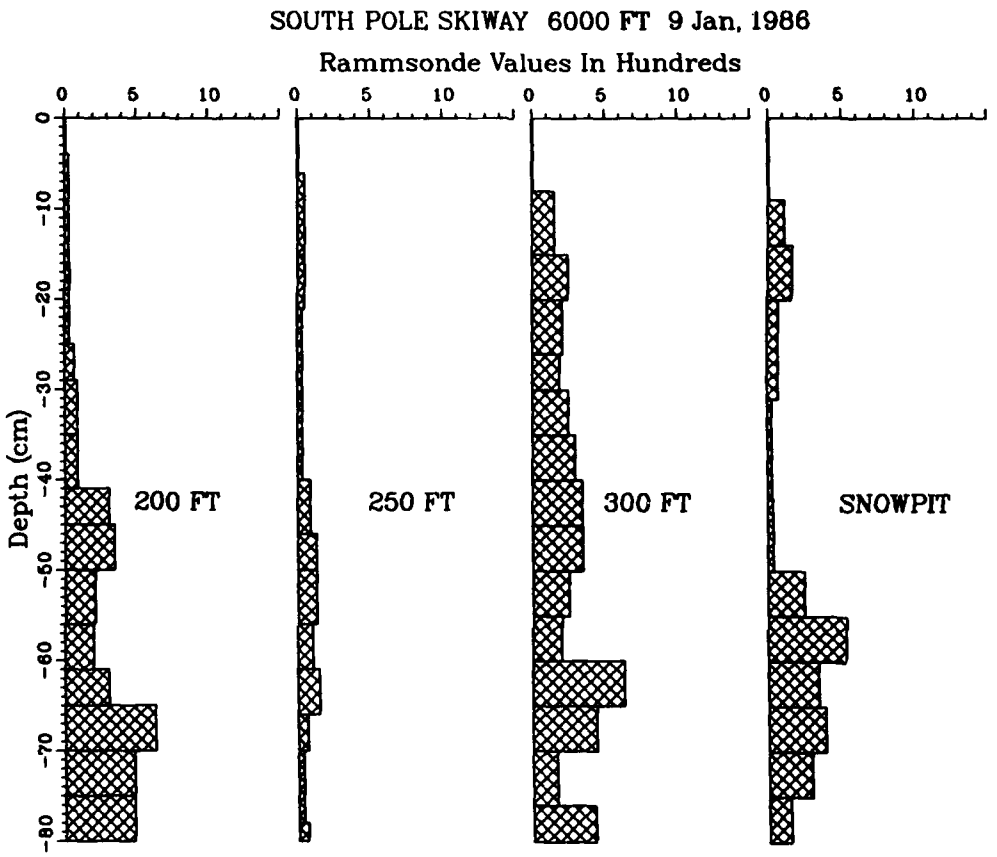
CONE TYPE : 30

W	H	N	D	X	W*H*N/X	W+Q	R
3	40	0	9	0	0	4	8
3	40	1	14	5	24	4	112
3	40	4	20	6	80	4	168
3	40	3	31	11	32.72727	4	73
3	40	1	42	11	10.90909	4	30
3	40	1	50	8	15	4	38
3	40	5	55	5	120	4	248
3	40	11	60	5	264	4	536
3	40	7	65	5	168	4	344
3	40	8	70	5	192	4	392
3	40	6	75	5	144	4	296
3	40	3	80	5	72	4	152

SOUTH POLE SKIWAY 6000 FT 9 Jan, 1986

Rammsonde Values In Hundreds




SOUTH POLE SKIWAY 6000 FT 9 Jan, 1986
Rammsonde Values In Hundreds
0
5
10
Depth (cm)
0
-10
-20
-30
-40
-50
-60
-70
-80
200 FT
250 FT
300 FT
SNOWPIT

RAMMSONDE HARDNESS AT SOUTH POLE STATION

South Pole Skiway comparison between 30° and 60° Ramm cones

FILENAME : B:SPSW30E6.J10

LOCATION : SOUTH POLE SKIWAY 6000' AT EDGE

SURFACE DESCRIPTION : UNDISTURBED

DATE : 1/10/86

TIME : 13:45

SNOW TEMPERATURE :

AIR TEMPERATURE :

CONE TYPE : 30

W	H	N	D	X	W*H*N/X	W+Q	R
1	20	0	9	0	0	2	4
1	20	1	16	7	2.857143	2	14
1	20	3	20	4	15	2	34
1	20	4	25	5	16	2	36

FILENAME : B:SPSW60E6.J10

LOCATION : SOUTH POLE SKIWAY 6000' AT EDGE

SURFACE DESCRIPTION : UNDISTURBED

DATE : 1/10/86

TIME : 13:50

SNOW TEMPERATURE :

AIR TEMPERATURE :

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
1	20	0	4	0	0	2	2
1	20	1	9	5	4	2	28
1	20	2	15	6	6.666667	2	9
1	20	6	20	5	24	2	26
1	20	5	25	5	20	2	22

FILENAME : B:SPSW3016.J10

LOCATION : SOUTH POLE 6000' 100' FROM EDGE

SURFACE DESCRIPTION :

DATE : 1/10/86

TIME : 13:40

SNOW TEMPERATURE :

AIR TEMPERATURE :

CONE TYPE : 30

W	H	N	D	X	W*H*N/X	W+Q	R
1	30	0	5	0	0	2	4
1	30	1	14	9	3.333333	2	15
1	30	5	20	6	25	2	54
1	30	15	25	5	90	2	184

FILENAME : B:SPSW.6016.J10

LOCATION : SOUTH POLE 6000' 100' FROM EDGE

SURFACE DESCRIPTION :

DATE : 1/10/86

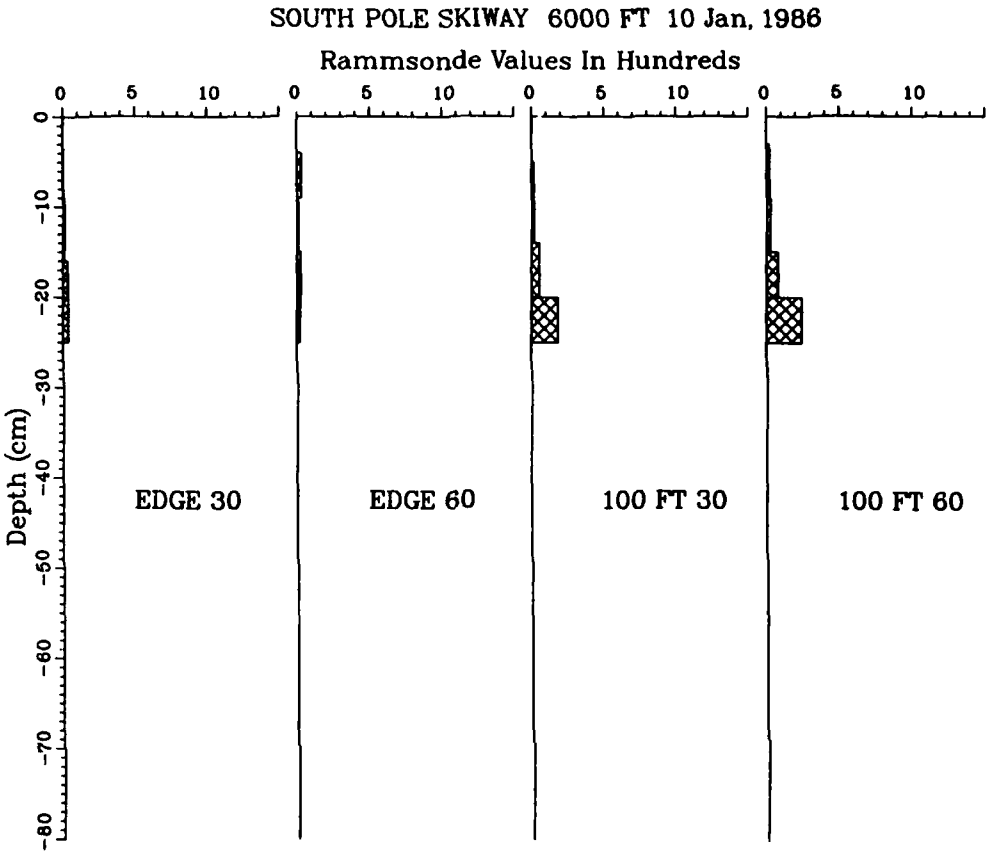
TIME : 13:35

SNOW TEMPERATURE :

AIR TEMPERATURE :

CONE TYPE : 60

W	H	N	D	X	W*H*N/X	W+Q	R
1	30	0	3	0	0	2	2
1	30	1	9	6	5	2	21
1	30	5	15	6	25	2	27
1	30	13	20	5	78	2	80
1	30	40	25	5	240	2	242


SOUTH POLE SKIWAY 6000 FT 10 Jan, 1986
Rammsonde Values In Hundreds
0
5
10
Depth (cm)
0
-10
-20
-30
-40
-50
-60
-70
-80
EDGE 30
EDGE 60
100 FT 30
100 FT 60

RAMMSONDE HARDNESS AT SOUTH POLE STATION

South Pole miscellaneous Ramm test locations

FILENAME : B:SPTW.J09

LOCATION : SOUTH POLE TAXIWAY FRONT OF CER. POLE

SURFACE DESCRIPTION :

DATE : 1/9/86

TIME : 15:40

SNOW TEMPERATURE :

AIR TEMPERATURE :

CONE TYPE : 30

W	H	N	D	X	W*H*N/X	W+Q	R
3	40	0	1	0	0	4	8
3	40	7	10	9	93.33334	4	273
3	40	11	15	5	264	4	536
3	40	12	20	5	288	4	584
3	40	13	25	5	312	4	632
3	40	12	30	5	288	4	584
3	40	7	35	5	168	4	344
3	40	3	40	5	72	4	152
3	40	2	45	5	48	4	104
3	40	6	50	5	144	4	296
3	40	10	55	5	240	4	488
3	40	6	60	5	144	4	296
3	40	4	65	5	96	4	200
3	40	3	70	5	72	4	152
3	40	3	76	6	60	4	128
3	40	2	80	4	60	4	128

FILENAME : B:SPNGMA.J09

LOCATION : SOUTH POLE NEW GEN. MOD. AREA

SURFACE DESCRIPTION :

DATE : 1/9/86

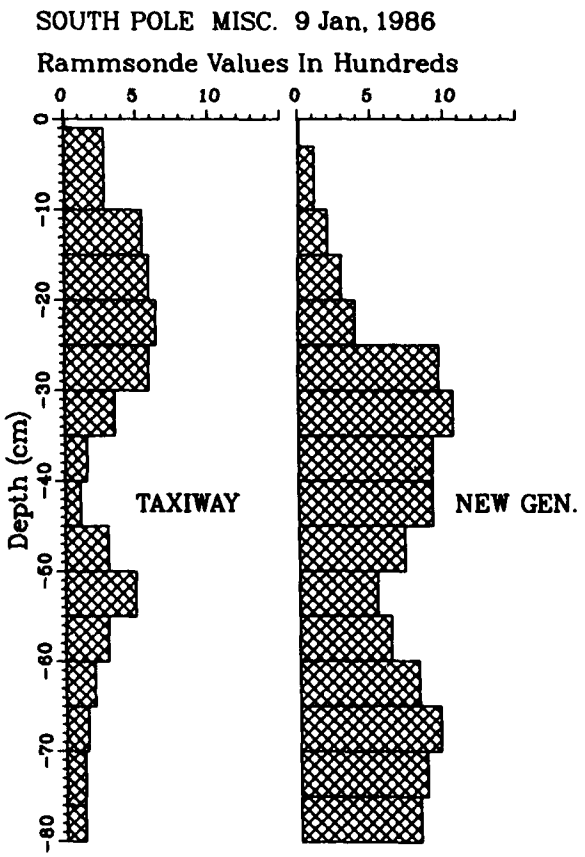
TIME : 15:50

SNOW TEMPERATURE :

AIR TEMPERATURE :

CONE TYPE : 30

W	H	N	D	X	W*H*N/X	W+Q	R
3	40	0	3	0	0	4	8
3	40	2	10	7	34.28571	4	107
3	40	4	15	5	96	4	200
3	40	6	20	5	144	4	296
3	40	8	25	5	192	4	392
3	40	20	30	5	480	4	968
3	40	22	35	5	528	4	1064
3	40	19	40	5	456	4	920
3	40	19	45	5	456	4	920
3	40	15	50	5	360	4	728
3	40	11	55	5	264	4	536
3	40	13	60	5	312	4	632
3	40	17	65	5	408	4	824
3	40	20	70	5	480	4	968
3	40	18	75	5	432	4	872
3	40	17	80	5	408	4	824


SOUTH POLE MISC. 9 Jan, 1986
Rammsonde Values In Hundreds
0
5
10
0
5
10
0
-10
-20
-30
-40
-50
-60
-70
-80
Depth (cm)
TAXIWAY
NEW GEN.

FILENAME : B:SPLGPT.J09

LOCATION : SOUTH POLE LGP TRACK

SURFACE DESCRIPTION :

DATE : 1/9/86

TIME : 16:05

SNOW TEMPERATURE :

AIR TEMPERATURE :

CONE TYPE : 30

W	H	N	D	X	W*H*N/X	W+Q	R
3	40	0	0	0	0	4	8
3	40	12	10	10	144	4	414
3	40	9	15	5	216	4	440
3	40	21	20	5	504	4	1016
3	40	40	25	5	960	4	1928
3	40	40	30	5	960	4	1928
3	50	25	35	5	750	4	1508
3	50	24	40	5	720	4	1448
3	50	22	45	5	660	4	1328
3	50	22	50	5	660	4	1328
3	50	25	55	5	750	4	1508
3	50	20	60	5	600	4	1208
3	50	19	65	5	570	4	1148
3	50	20	70	5	600	4	1208
3	50	21	75	5	630	4	1268
3	50	21	80	5	630	4	1268

FILENAME : B:SPST.J09

LOCATION : SOUTH POLE SCRAPER TRACK

SURFACE DESCRIPTION :

DATE : 1/9/86

TIME : 16:35

SNOW TEMPERATURE :

AIR TEMPERATURE :

CONE TYPE : 30

W	H	N	D	X	W*H*N/X	W+D	R
3	50	0	1	0	0	4	8
3	50	4	10	9	66.66666	4	198
3	50	15	15	5	450	4	908
3	50	31	20	5	930	4	1868
3	50	29	25	5	870	4	1748
3	50	23	30	5	690	4	1388
3	50	22	35	5	660	4	1328
3	50	16	40	5	480	4	968
3	50	15	45	5	450	4	908
3	50	15	50	5	450	4	908
3	50	10	55	5	300	4	608
3	50	10	60	5	300	4	608
3	50	14	65	5	420	4	848
3	50	13	70	5	390	4	788
3	50	20	75	5	600	4	1208
3	50	24	80	5	720	4	1448

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